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BULLETIN No. 3.

GOLD DEPOSITS OF NORTH CAROLINA.

BY

HENRY B. C. NITZE

AND

GEORGE B. HANNA.

WINSTON:
M. I. & J. C. STEWART, Public Printers.
1896.

Gold Deposits of North Carolina

Bulletin No 3

PARTIAL LIST OF GOLD MINES

LOCATED ON THE ACCOMPANYING MAP OF NORTH CAROLINA.*

1. Portis mine, Franklin county.
2. Mann-Arrington mine. Nash county.
3. Arrington mine, " "
4. Roberson mine, Orange "
5. Belle mine, Moore "
6. Burns mine, " "
7. Cagle mine, " "
8. Clegg mine, " "
9. Brown mine, " "
10. Hoover Hill mine, Randolph "
11. Wilson Kindley mine, " "
12. Jones mine, " "
13. Parish mine, " "
14. Davis Mt. mine, " "
15. Sawyer mine, " "
16. Winslow mine, " "
17. Uharie mine, " "
18. Emmons mine, Davidson "
19. Cid mine, " "
20. Silver Hill mine, " "
21. Silver Valley mine, " "
22. Conrad Hill mine, " "
23. Welborn mine, " "
24. Russell mine, Montgomery "
25. Appalachian mine, " "
26. Steele mine, " "
27. Riggon Hill mine, " "
28. Beaver Dam mine, " "
29. Moratock mine, " "
30. Reynolds mine, " "
31. Carter mine, " "
32. Sam Christian mine, " "
33. Haithcock, Hearne and Lowder mines, Stanly "
34. Crawford mine, Stanly "
35. Parker mine, " "
36. Barringer mine, " "
37. Gold Hill mines, Rowan "
38. Rocky River mines, Cabarrus "
39. Buffalo mines, " "
40. Nugget mines, " "
41. Crowell mines, Union "
42. Long mines, " "
43. Moore mine, " "
44. Stewart and Lemmonds mines, Union "
45. Crump and Butterfield mines, Union "
46. Henry Phifer mine, Union "
47. Fox Hill mine, " "
48. Black mine, " "
49. Smart and Secrest mines, " "
50. Moore Hill, Folger Hill, Davis, Phifer, Lewis and Hemby mines, Union "
51. Bonnie Bell mine, Union "
52. Howie mine, " "
53. Hamilton and Cox mines, Anson "
54. Hodges Hill mine, Guilford "
55. Fisher Hill and Millis Hill mines, Guilford "
56. Twin mine, Guilford "
57. North Carolina mine, Guilford "
58. Gardner Hill mine, " "
59. North State and Lindsay mines, Guilford "
60. Deep River mine, Guilford "
61. Lalor and Loftin mines, Davidson "
62. Eureka mine, Davidson "
63. Negus, Harrison, Hill, Southern Belle, Goodman and Randleman mines, Rowan "
64. New Discovery mine, Rowan "
65. Dunn Mt. mine, " "
66. Reimer mine, " "
67. Bullion mine, Rowan county.
68. Gold Knob mine, " "
69. Dutch Creek mine, " "
70. Phœnix and Barrier mines, Cabarrus "
71. Faggart mine, Cabarrus "
72. Barnhardt mine, " "
73. Tucker mine, "
74. Quaker City mine, " "
75. Reed mine, " "
76. Pioneer Mills mines " "
77. Davidson and Point mines, Mecklenburg "
78. Rudisil mine, Mecklenburg "
79. St. Catharine mine, " "
80. Smith and Palmer mine, Mecklenburg "
81. Taylor mine, Mecklenburg "
82. Trotter mine, " "
83. Clark mine, " "
84. Parks mine, " "
85. Brawley mine, " "
86. Todd mine, " "
87. Arlington mine, " "
88. Stephen Wilson, Gibson and Neal mines, Mecklenburg "
89. Capps, McGinn and Means mines, Mecklenburg "
90. G. C. Cathey, Sloan and Chapman mines, Mecklenburg "
91. Dunn mine, " "
92. Henderson mine, " "
93. Ferris mine, " "
94. Hunter mine, " "
95. Tredinick mine, " "
96. Ray mine, " "
97. Simpson and Black mines, Mecklenburg "
98. Ellington, Surface Hill, Ferguson Hill, etc., mines, Mecklenburg "
99. King's Mt. mine, Gaston "
100. Crowder's Mt. mine, Gaston "
101. Rhodes mine, " "
102. McLean mine, " "
103. Duffie, Robinson, Derr, etc., mines, Gaston "
104. Burrell Wells mine, Gaston "
105. Oliver mine, " "
106. Long Creek mine, " "
107. Graham mine, Lincoln "
108. Shuford mine, Catawba "
109. Maiden mine, " "
110. Rufty mine, " "
111. Abernathy mine, " "
112. Butler mine, Davie "
113. Callahan Mt. mine, Davie "
114. Isaac Allan mine, " "
115. Clarksville mine, " "
116. Fulton mine, " "
117. Dixon mine, Yadkin "
118. Hancock mine, Burke "
119. Carolina Queen mine, Burke "
120. J. C. Mills mine, " "
121. Marion Bullion mine, McDowell "
122. Vein Mt mine. " "
123. Alta mine, Rutherford "
124. Ellwood and Leeds mines, Rutherford "
125. Brown Mt. mine, Burke "
126. Baker, Bald Knob, Pax Hill, Scott Hill, &c., mines, Caldwell "
127. Bee Mt. mine. " "
128. Flint Knob mine, Wilkes "
129. Copper Knob mine, Ashe "
130. Boylston mine, Henderson "

*The symbols and numbers for the mines are printed on the map in red.

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813b

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., Nov. 30, 1895.

To His Excellency, HON. ELIAS CARR,

Governor of North Carolina.

SIR:—I have the honor to submit for publication as Bulletin 3 of the Geological Survey, a preliminary report on the Gold Deposits of North Carolina; prepared by Mr. Henry B. C. Nitze, of the Geological Survey, and Mr. George B. Hanna, of the U. S. Assay office at Charlotte. There are many enquiries for information concerning the gold deposits of the State, and in response to these I recommend the publication of this Bulletin.

Yours obediently,

J. A. HOLMES,

State Geologist.

PREFACE.

This preliminary report owes its appearance to the fact that during the past few years there has been a growing interest in the South Appalachian gold fields, and the resulting inquiries have shown that mining operations in many portions of this region are in an exceedingly unsatisfactory condition, and that there were but few publications to be found relating to the subject,—and these of a somewhat unsatisfactory character.

With a view of helping to remedy, as far as might be possible this state of affairs, a preliminary investigation was undertaken by the United States Geological Survey, of this gold region as a whole, and investigations have also been undertaken by the Geological Surveys of several of the states included in this area. Results of the investigations undertaken for the U. S. Geological Survey by Mr. Geo. F. Becker, and the preliminary results obtained by the State Survey in Alabama have been published. Several years ago (1887) a paper on the gold deposits and mines in North Carolina was also published, but this discussion of the subject is now nearly out of print.*

During the past two years a study of the North Carolina gold fields has been made by Mr. H. B. C. Nitze of the State Geological Survey, and by Mr. Geo. B. Hanna of the United States Assay Office at Charlotte, at such times as he could be absent from his duties there. The extent and nature of their work is described in more detail below. During the past year Mr. Nitze, assisted by Mr. H. A. J. Wilkens of Baltimore, has visited practically all of the mines now in operation in the South Appalachian gold field for the purpose of studying the mining and metallurgical methods in use. A statement of the results of their investigations was presented at the Atlanta meeting of the American Institute of Mining Engineers (October, 1895), and is now being printed in the Transactions of the Institute. A more elaborate report by them on this subject will be shortly published as one of the bulletins of this survey.

---

*"The Ores of North Carolina": being chapter 2 of the 2nd volume of the Geology of North Carolina, by W. C. Kerr and Geo. B. Hanna, Raleigh, 1887. pp. 233-359.

With a view to the preparation of the present report on the Gold Deposits of North Carolina, Mr. Nitze began field explorations in the spring of 1894. During the latter part of May and June some preliminary examinations were made in Stanly, Rowan, Cabarrus, Mecklenburg, Gaston, and Chatham counties. From the end of June to the beginning of November field work was pursued in the South Mountain region, embracing the counties of Burke, McDowell and Rutherford. This work was also extended into Henderson, Caldwell and Wilkes counties.

During the month of November, Mr. Nitze was accompanied by Mr. Geo. F. Becker, and the latter's assistant, Mr. C. W. Purington, of the U. S. Geological Survey, on a reconnaisance trip through Union, Cabarrus, Rowan, Montgomery, Davidson, Randolph, Moore, Chatham, Franklin and Nash counties. During the winter of 1894–'95 he was engaged in writing up the results of his field work, and in making a petrographic study of a number of rock specimens collected in the course of the field explorations. This work was pursued at the offices of the U. S. Geological Survey in Washington, D. C., where he had the cordial assistance of Mr. Becker and his associates.

The time in which it has been necessary to prepare the report of his work, together with other duties, did not allow of a microscopic examination of all the specimens collected, and some work still remains to be done in that direction. During the summer of 1895, investigations were continued in the field, prior to the final writing of this report.

Mr. Geo. B. Hanna, of the U. S. Assay Office at Charlotte, prepared a complete revision of the section on Gold Ores in "The Ores of North Carolina," and has added in this revision the results of his field observations in the gold belts made during the past few years.

In order to bring together all the available data concerning the several gold bearing regions, it was necessary to combine these two reports, and this somewhat difficult task was assigned to Mr. Nitze, who has brought together the subject matter of the two manuscripts in such a way as to present the most logical arrangement of the subject. In the report as published, the geological descrip-

tions and discussions are solely his. The descriptions of the mines are in part his, in part Mr. Hanna's, in part a consolidation of the statements of both.

Many of the facts contained in these descriptions, relating to the old mine workings, thickness of the ore bodies, etc., have been obtained from the personal statements of superintendents of the mines, foremen, miners, etc., and the authors do not hold themselves responsible for these. The majority of the mines described are not in active operation; most of them being at the present time in an abandoned and inaccessible condition. Unless otherwise stated in this report, the mines described are not now being worked.

It is well known that assays of gold ores are of little importance as showing the working value of an ore body, unless very large quantities can be properly sampled in a sampling works, of which there are none in the South. The readers are, therefore, warned not to be misled by assays that are given in this report; they are given to show comparative approximate values, or variations in different parts of the same ore body. Though it ought to be said that, excluding the high grade assays, many of the samples represent fairly well actual ore bodies of greater or less magnitude. The only safe criterion of the value of an ore is a mill test.

Unless otherwise stated, the assays given in this report, have been made by Mr. Hanna. The gold and silver have been valued at their coining rates, viz: Gold $20.67 per fine ounce, and Silver $1.293 per fine ounce. This is plain as to gold, for the coining and commercial rate are practically the same; but with silver the commercial rate varies greatly, and those who are especially interested must correct the stated valuation by the commercial rate of the day. The ton mentioned in the assays is invariably 2000 pounds.

Mr. Chas. E. Cooke, topographer, of the U. S. Geological Survey, was engaged from October 10th to the latter part of November in revising the S. W. quarter (250 square miles) of the Morganton Atlas sheet, on a scale of one mile to the inch, with contour intervals of 50 feet. The map of the South Mountain region published in this report (plate XII) is the result of Mr. Cooke's excellent survey.

J. A. Holmes.

THE GOLD DEPOSITS OF NORTH CAROLINA.

By H. B. C. Nitze and Geo. B. Hanna.

CHAPTER I.

THE GOLD-PRODUCING AREA AND ITS DEVELOPMENT.

The area of the gold-bearing rocks; historical notes; gold and silver production in North Carolina; character and fineness of the gold and silver; the gold-bearing rocks; nature of the ore deposits.

AREA OF THE GOLD-BEARING ROCKS.

The formations of about one-half of the area of North Carolina may be considered as gold bearing, but the productive part of this area, i. e. the part which at one or another period has been exploited to any considerable extent will not exceed 8,000 or 10,000 square miles. There are at least 350 localities in the State which have earlier or later been worked for gold. At the present time 18 mines are in operation.

Warren county on the northeast, Moore county on the southeast, and the Tennessee line on the west, mark approximately the eastern and western boundaries of the North Carolina gold field as a whole. It passes into Virginia on the north, and into South Carolina and Georgia on the south.

This general field may be divided geologically and geographically into the following six groups or belts, the general location of which is indicated on the accompanying small map (Plate I):

1. The Eastern Carolina Belt.
2. The Carolina Slate Belt.
3. The Carolina Igneous Belt.
4. The Kings Mountain Belt.
5. The South Mountain Belt.
6. The mines west of the Blue Ridge.

These various belts are not in all instances clearly outlined or well marked, and might on extended study be subject to still further differentiation or other revision.

However, they serve the purpose here of simplifying and facilitating the descriptions of the geological features and the distribution of the mines.

Each belt will be taken up and treated separately in the following portions of this report.

HISTORICAL NOTES.

At what time gold mining was first undertaken in North Carolina cannot be ascertained, but several traditions, which carry a large probability of truth, would seem to indicate that the auriferous character of the section was known before the Revolutionary war. One of the localities in this State, which it is believed was worked before that struggle began, was the Oliver mine in Gaston county. The Brewer mine in Chesterfield county, South Carolina, is another; and the "Aborigines" shaft, at this latter place, is still pointed out where work was done earlier than any known records. Information has recently been received of the successful operation of the Parker mine in Cherokee county, N. C., by the Cherokee Indians long before the coming of the white pioneers into that section. They obtained only nugget gold and their art was entirely inadequate to the winning of the fine dust gold.

The first authentic find was on the Reed plantation, in Cabarrus county, where a 17 pound nugget was found in 1799. Its value was not suspected at first, but when it was ascertained to be gold, a systematic search was undertaken, and a large number of nuggets were unearthed.[1]

Success at this mine stimulated search elsewhere; nugget gold was found at the Dunn mine in Mecklenburg county soon afterwards, and curious stories are still current of the common uses to which these nuggets were put by the local gunsmiths.

By 1825 gold mining on a vigorous scale was carried on along the entire Appalachian slope, from Virginia to Alabama. The placers or like deposits were first worked, then the gossan outcrops of the veins, where slight skill with few and cheap appliances were adequate to the work. The exhaustion of these easily worked stores was effected about the time of the discovery of gold in Cal-

[1] Emmons' Geology of the Midland counties of North Carolina, 1856, page 166.

ifornia and there was a large exodus of miners to that territory. The mining work had not recovered from the retarding influences of this exodus when the civil war came and put an end to all work. At the close of the war but one gold mine in North Carolina was in operation. Since then there have been spasmodic revivals and depressions in gold mining throughout the State, and at the present time everything points to a healthy growth of the industry.

GOLD AND SILVER PRODUCED IN NORTH CAROLINA.

The total amount of the precious metals produced by the mines of North Carolina up to Nov. 30th, 1894, so far as the United States records offer evidence is as follows:

Gold (coining rate)	$11,754,369.60
Silver " "	63,620.40
Total,	$11,817,990.00

It is certain, however, that this is but a part of the production, for much of it is known to have been exported directly by companies having headquarters abroad. Moreover, up to the time of the discovery of gold in California, there was a large demand for native gold by jewelers, and the Carolina gold was in request on account of its beauty. It is not an unreasonable conjecture that the amount which has in various ways escaped official notice is as large as that on record; and that the total amount produced in the State can hardly have been less than $24,000,000.00.

It should be added that the statistics for silver are trebly obscure, for in addition to the vicissitudes observed in the disposition of the gold mined in North Carolina, this metal has passed in a much greater proportion than gold directly into the channels of commerce, through private refineries and smelting works, inasmuch as since 1873 the United States Mint has not purchased silver from depositors. The fluctuating and low price of silver since 1873 as compared with the coining rate is also confusing. The silver produced in the State, at its coining rate, would probably be swollen in even greater proportion than that of the gold.

The following statistics since 1880 are given, from the records of the United States Mint:

North Carolina State Library
Raleigh

TABLE I. *Gold and Silver produced in North Carolina, deposited at the United States Mint and Assay offices.*

YEAR.	GOLD.	SILVER.	YEAR.	GOLD.	SILVER.
1880	$ 77,405.30	$ 395.33	1888	$ 88,641.47	$ 2,787.80
1881	55,989.97	510.12	1889	81,196.33	7,803.12
1882	82,472.84	662.96	1890	75,192.13	1,644.77
1883	100,293.84	797.57	1891	53,992.75	512.96
1884	88,861.11	568.09	1892	50,335.67	475.96
1885	64,826.25	591.07	1893	36,454.49	348.44
1886	83,400.20	784.71	1894	46,592.45	454.83
1887	216,788.08	2,756.37			

TABLE II. *Estimate of the production of Gold and Silver (combined) in North Carolina.*

1880	$ 95,000	1885	$ 155,000	1890	$ 126,397
1881	115,000	1886	178,000	1891	101,477
1882	215,000	1887	230,000	1892	90,196
1883	170,000	1888	139,500	1893	70,505
1884	160,500	1889	150,174	1894	52,927

CHARACTER AND FINENESS OF GOLD AND SILVER.

With the exception of minute quantities of telluride of gold at the Kings Mountain mine, and possibly a few others, the gold in this State is believed to exist in the metallic state, and is invariably alloyed with silver, in proportions varying from 50 to 600 one-thousandths of silver.

Native silver was found in some quantity at the Silver Hill mine in Davidson county, at the McMackin and Troutman mines near Gold Hill, and at the Copper Knob mine in Ashe county. Sulphide of silver is also reported to have been seen at the latter mine. Chlorides and bromides, with their associated minerals, are found only in extremely small quantities, and are of no importance commercially.

Outside of these associations, silver is found in the galenas and zinc-blendes, with commonly only a small content in gold. Zinc ores, dissociated from galena, are very rare, while lead ores free from large amounts of zinc are also infrequent. In a word, the lead

ores of North Carolina are usually zinciferous; they are commonly argentiferous, and to a slight extent auriferous.

The fineness of native gold varies throughout the State, and to a large extent with the different formations in which it occurs. The Eastern Carolina belt shows a variable fineness at the different points. Thus, toward the northern part of the State, well up to the Virginia line, assays show the gold to be about 925 m. fine, with from 60 to 75 m. silver and a *very* little iron, and occasionally a trace of copper; at the Portis mine in Warren county, for example, very rarely does the fineness reach to 950 m. Further south, in Moore county, the range in fineness is from 700 to 750 (rarely 850) gold, and 225 to 300 silver, with similar base constituents. In the first mentioned locality, the gold is almost entirely "placer"; in the latter it is partly derived from a mill treatment of the schists.

Throughout this entire area, arsenic, antimony, etc., are rare in the native gold, and it is not quite certain that these metals may not have been introduced by careless manipulation.

In the Carolina Igneous region, gold ranges from 800 to 950 (*very* rarely 975). Thus, for example, at the North State, Phœnix, Reed, Capps and Rudisil mines, 900 to 925 would characterize the average, with a trifle more iron, and sometimes with as much as 5 to 10 of copper—for the gold comes from veins, which carry large bodies of chalcopyrite.

In the Carolina Slate region, just to the east of this Carolina Igneous belt, the gold is derived from schists, which often carry pyrites or galenites, and these, especially the galenites, have apparently had a large influence in lowering the grade, which rarely rises to 900; examples of this may be seen at the Howie, where the fineness of the gold varies from 725 to 775; at Gold Hill, from 850 to 900; at the Phifer, from 750 to 800; and most frequently the fineness will not rise above 825. Where galenite is abundant, the proportion of gold is reduced to 450, and on rare occasions to a still lower point, as, for example, at the Davis mine, we find gold as low as 450, and sometimes less; at the Stewart, gold 550, silver 447. The native gold itself does not often contain more than a trace of lead.

In the extreme western part of the State, the gold is almost wholly placer gold, and occurs more or less in nuggets. The fineness is rarely as low as 800, and most generally runs above 900—occasionally rising to 980—with the least possible amount of base metal.

In the Burke county mines (South Mountain belt) which are chiefly placer, the gold is tolerably uniform, from 825 to 850, as may be observed at the J. C. Mills mines, the Hancock mine, and the Brindletown localities generally. In the adjacent county, McDowell, the grade lessens to 780 or 800; as at the Vein Mountain mine. In Rutherford county it rises to nearly 900. In Polk county the fineness again rises, being rarely less than 900, and often more than 950; as may be observed at the Double Branch, and the Splawn mines.

When it is said that iron is found in native gold, the statement must not pass without some qualification, for in some cases it is known to be due to a slight proportion of oxide of iron, mechanically contained in the minute cells of the nuggets or grains. And the same has also been occasionally observed of oxide of copper.[1]

THE GOLD-BEARING ROCKS.

The auriferous deposits of North Carolina are contained in the crystalline rocks, which cover more than one-half the area of the State. These rocks include gneisses, metamorphosed schists and slates, siliceous limestone, granite, diorite, diabase and other plutonic eruptives, devitrified ancient volcanics, and pyroclastic breccias. In part (limestones and some of the slates), they show evidence of sedimentary origin, but they are all metamorphosed to such a degree that they are included here under the general term crystalline rocks.

The age of these rocks is not definitely known, but they appear to be Archean, Algonkian, and probably in part Paleozoic.

In the southeastern portion of the gold field, in Union, Stanly and Montgomery counties, is an area of little indurated, bedded slates, of undoubted sedimentary character, which have been

[1] See further the *Engineering and Mining Journal*, September 18, 1886. G. B. Hanna.

called the "Monroe" slates. These are intersected by small auriferous quartz fissures, but their economic value is of little importance.

The Jura Trias (Newark) conglomerates, bordering on the eastern edge of the gold-bearing crystalline rocks, have in several instances (Chatham county) been shown to be very slightly auriferous, but this fact is purely of scientific and not of commercial interest.

STRUCTURE OF THE ORE DEPOSITS.

Structually, the ore deposits are of two principal types: (1) quartz fissure veins containing free gold, and gold in combination with sulphurets. (2) impregnations of free gold and finely divided auriferous sulphurets in the country schists and slates, sometimes accompanied by small lenticular quartz intercalations.

The quartz fissure veins in turn may be differentiated into (*a*) clean cut fissures, intersecting the massive rocks, such as granites, diorites, etc., or cutting the schistosity of the gneisses and schists, both in dip and strike, at a well defined angle; (*b*) a system of larger and smaller lenticular veins of more or less definite extent, approximately conformable to the schistosity of the rocks, but also intersecting the same, usually at small angles, and sometimes cutting across from one lamination to another, or sending off irregular and discontinuous stringers into the wall rock; (*c*) a system of reticulated veins.

The second class, the auriferous schists, are sometimes hundreds of feet in width, though not by any means necessarily capable of being worked profitably in their whole extent. Almost invariably the larger the ore body, the lower the grade of the ore; and these large bodies of auriferous schist form the low grade ores of North Carolina, as they do throughout the entire southern Appalachian, as well as other gold fields.

The gold is not uniformly distributed in the ore bodies; both the veins and schists have "chimneys" or "shoots" in which the gold is concentrated, leaving the intermediate parts relatively poor, though all parts commonly have some valuable contents. These "shoots" have a pitch of their own in the vein or ore body.

The line of separation is not clearly defined, except to the experienced miner, who can discriminate the limits of the secondary action, which has charged the "shoots".

Moreover, the country rock in the vicinity of the ore bodies almost everywhere carries some sulphurets (usually pyrite), which contain at least a trace of gold.

INFLUENCE OF WEATHERING AGENCIES ON THE ORE BODIES.

The entire surface of the country has long been subject to weathering agencies; and as a result the rocks, together with the auriferous bodies contained in them, have been decomposed to considerable depths, occasionally reaching 200 feet. Nearly or quite to the depths of these alterations, and almost always to the permanent water line, which is rarely more than 50 feet from the surface, the gold is in a free condition.

In these upper, decomposed portions (the gossan) of the ore bodies the pyrite is for the most part changed to brown hematite (brown ore), the copper sulphides have become malachite (rarely azurite), chrysocalla, and occasionally either black or red oxide of copper, or else the copper constituents have been almost entirely leached out, and similarly the lead and zinc sulphides have been altered. The decomposed "brown ore" holds not only the gold, which was originally in the sulphurets, but it has been further enriched as a result of the alterations which have taken place, as is evidenced by the presence of nuggets and grain gold, which is always found in this zone more abundantly than in the deeper ores. Ores of this class are not difficult to work, and require little and inexpensive machinery. The treatment is rather a mechanical process than a metallurgical one, and with close attention to the process a large part of the precious contents is extracted at a small cost. The larger bodies of brown ores have by this time been practically exhausted, and the work henceforth must generally be on the deeper, more complex, and as a rule, less rich ores.

Below the water level the ores are only partly altered at most. However, native gold is often found attached to the sulphurets,

and a simple concentration of the ores will generally disclose free gold. But the yield by stamp-mill amalgamation alone is seldom sufficient to be remunerative, and the ores must be submitted to further mechanical and metallurgical treatment for the extraction of the gold from the sulphurets.

The cost of mining is also largely increased, chiefly as it becomes necessary to use pumping and other machinery, the purchase and maintainance of which are heavy expenses.

The narrow seams and veinlets of quartz, which are extraordinarily abundant in the North Carolina gold field, and which traverse the country in many directions, are oftentimes comparatively rich in gold. The weathering agencies have in time liberated the gold from these veinlets, and from the decomposed masses of country rock, and subsequently concentrated it on the bed of undisturbed rock, or in the streams, thus forming the placer deposits.

CHAPTER II.

THE EASTERN CAROLINA BELT.

GENERAL DESCRIPTION.

This embraces the extreme northeast deposits of the State, in the counties of Warren, Halifax, Franklin and Nash, (see plate I, page 15). The present known area over which the mines are distributed is not less than 300 square miles, extending from the Thomas mine, 1½ miles northeast of Ransom's Bridge, in a southwesterly direction to the Tar river; and it is possible that these boundaries will ultimately be enlarged both to the north and south, and even to the east into the region now covered by recent sands and clays.

On the west this area is bounded by the Louisburg granite.

The country rocks are diorite, chloritic schist, and gneiss. The great abundance of quartz veinlets, from a line to 1½ inches in thickness, is very conspicuous in this district. They commonly run with the lamination, but sometimes cross both the strike and dip of the schistosity; occasionally they occur in considerable numbers close together and constitute a true ore channel. They consist generally of sugary or granular quartz, often seamed and filled with oxide of iron, and are always soft and easily crushed. The smaller seams are usually the richer. The gold appears originally to have been in these narrow seams of quartz, which have been broken down in the process of weathering, and the fragments of which are widely distributed through the soil, and are generally most abundant on the bed rock, 15 to 25 feet below the surface, or in favored sinks and channels.

The richer parts of this district have been worked 60 or 70 years, but those parts which are most accessible to water have been so far exhausted as to be no longer profitable under the simple methods so long practiced; hence the almost total cessation of the heretofore small hydraulic operations, although hydraulic work on a large systematic scale may in many cases be quite feasible.

A large amount of quartz has been accumulated by such work; most of this is auriferous, and capable of being milled at a small profit, as indicated by the following assays:

Assays of free-milling quartz, Eastern Carolina Belt.

	(1)	(2)	(3)
Gold (per ton)	$2.07	$3.10	$2.59
Silver (per ton)	trace.	trace.	trace.

Most of the mines of this district have the same salient characteristics and demand the same mode of treatment; though some, like the Portis, are situated on elevated land, and are not naturally well supplied with water.

A combined hydraulic and milling method, such as is used so extensively in Dahlonega, Georgia, may in many cases be adaptable to the mines of the Eastern Carolina belt.

The production of this district has unquestionably been very considerable, but whether the three or four millions of dollars attributed to it can be substantiated may admit of some doubt.

GOLD DEPOSITS AND MINES IN THE EASTERN CAROLINA BELT.

Among the more noted mines of the region, which have been worked, are the following:

The Portis Mine[1] is situated near Ransom's Bridge in the northeastern corner of Franklin county, about 18 miles E. N. E. from Louisburg, on a hill 108 feet above Shocco creek, from which water for hydraulic work is obtained.

The only work of any consequence that has been done here was surface sluicing and some hydraulicking, to a depth of from 15 to 30 feet. Recently some prospect pits have been sunk on various portions of the property, but none of these extend to the water level, being entirely in the upper decomposed rock layer. Practically very little can be learned, either in regard to the true nature of the deposits in place, or the nature and relations of the country rock.

The country rock appears to be diorite, which in general is greatly decomposed and beyond recognition; only at a few points were fairly fresh specimens found.

[1]Geolog. Report of the Midland Counties of N. C., p. 140.

From a statement of Col. Sturgess, the owner, it appears that there are two main zones of ore, nearly at right angles to each other. One of these strikes about N. 50° E., and dips 25° S. E., as determined in a shallow prospect shaft. The ore body consists of a mass of small and large reticulated quartz veins (up to 2 feet thick) in the diorite, measuring about 9 feet in total width. The quartz is stained brown, and is for the most part of a saccharoidal character.

The other zone is known locally as the "White Belt", and, like the first, consists of a network of reticulated quartz veins. The thickness of the deposit is stated to be about 9 feet. It is called the "White Belt" presumably on account of the appearance of the decomposed diorite, which is a soft bleached mass. The strike is west of north, and the dip westward at a very low angle. A former miner stated, that in a distance of 300 yards to the west of the outcrop, the depth of the ore body was only 40 feet.

Some loose pieces of diabase were found near one of these openings, but not in place. It is stated that this rock occurs in boulders just above the ore of the "White Bank"; and it is possible therefore that the diabase exists as an intrusive dike lying with the ore body, nearly flat and above it, or it may exist in more vertical dikes somewhere. Its true relation could not be determined. At least one might say that it appears to be associated with the ore body.

It is stated that the upper decomposed rock layer is everywhere auriferous, and will pay to hydraulic. The scarcity of water is the great impediment. Small irregular quartz stringers occur promiscuously throughout the country rock.

At one point a line has been hydraulicked, and Col. Sturgess reports that 1000 cubic yards yielded 1018 pennyweights of gold, the loose vein rock obtained in this mass averaging about $8 per ton, assay value.

The Mann-Arrington Mine is situated in the northwest corner of Nash county, at Argo P. O., five miles southeast of Ransom's Bridge. The country rock is chloritic schist, in part porphyritic, some of the phenocrysts being $\frac{1}{8}$ inch in diameter. It may be a

metamorphosed diorite. The strike is N. 58° E., dip 40° S. E. The rock contains iron sulphurets, and quartz lenses, from minute size up to 12 inches in thickness. These lenses are interlaminated in the schist, and some were observed to cut the schistosity at low angles. The quartz is generally quite saccharoidal, and often of a reddish brown color from the decomposed sulphurets, having a "live" appearance for gold. It contains included fragments of chlorite. The mine has been worked to a depth of about 108 feet, but is now idle.

The Arrington Mine is in Nash county, one mile southeast of the Portis. The mine tract comprises nearly 2,000 acres of land extending two or three miles down Fishing Creek. After the Portis, this mine is the best known of the region.

The Thomas, Kearney, Taylor, Mann and Davis (in Halifax county), are other but less prominent mines of this region.

The Nick Arrington Mine is twelve miles east of the Portis.

The Conyers Mine is seven miles from Whitakers, on Fishing creek. There is an 18-inch vein of brown and sulphurretted ore, in addition to a large quantity of "pay" gravel. The shaft is 30 feet deep, and is reported to show milling ore all the way.

Near Springhope on Tar river, about 20 miles west of Rocky Mount, considerable surface washing has been done, and a large amount of gold extracted, but there has been no systematic work.

On the Woodward-Hedgepath tract, 2 miles from Nashville, a strong vein 3 feet wide has lately been opened up for a distance of more than one mile. The ore is cellular quartz, containing iron pyrites; adjacent is a parallel body of auriferous slates.

CHAPTER III.

THE CAROLINA SLATE BELT.

CHARACTER AND AGE OF THE ROCKS.

The term slate, as used in this connection, covers a broad designation. The country rocks of this important belt are:

1. Argillaceous, sericitic (hydromicaceous), and chloritic metamorphosed slates and crystalline schists.

2. Sedimentary pre-Jura-Trias slates.

3. Ancient volcanic rhyolites, quartz-porphyries, etc. (flint, hornstone, etc.), and pyroclastic breccias, often sheared.

This area of metamorphic slates and schists embraces a belt extending in a general southwesterly direction across the central part of the State, and varying in width from 8 to 50 miles. It is bounded on the west by the central igneous area (Emmons' pyro-crystalline rocks, Kerr's Lower Laurentian), and on the east for the greater part by the Jura-Trias; also in the northern part by a small area of Archean rocks (Kerr's Upper Laurentian); and in the southeastern part by a small embayment of the Coastal Plain. This is the so-called "great slate belt" of Olmsted, the "Taconic" of Emmons and the "Huronian" of Kerr.

In order to gain a more comprehensive oversight of this important geological area, it will be well to state in a few words both Emmons' conception of his Taconic, and Kerr's conception of his Huronian in this part of North Carolina, without comment; and then to discuss the same in the light of more recent investigation. This is by no means intended to be a general discussion of the Taconic question, but simply in so far as it refers to this particular zone of gold-bearing rocks. The investigations carried on in this field during the autumn of 1894 were of necessity very cursory and incomplete, and can only form the beginning of a more thorough study of the region later on.

EMMONS' TACONIC SYSTEM IN NORTH CAROLINA.[1]

Emmons places these rocks among the lowest members of the oldest sedimentaries, i. e., at the base of the Paleozoic.

[1] Geological Report of the Midland Counties of N. C., 1856; pp. 38-73.

"The formations of the midland counties, which occupy the largest extent of surface, are slates and siliceous rocks, which have been called quartzites." * * * * "The slates are variable in color and composition. They are mineralogically clay, chloritic and talcose slates, taking silica into their composition at times, and even passing into fine grits and hornestones, but still variable in coarseness. In the order in which they lie, the talcose slates and quartzites are the inferior rocks, though quartzites occur also in the condition of chert, flint or hornestones in all the series."

He establishes their sedimentary origin from the occurence of numerous beds containing rounded pebbles. Further, "many beds which look like sediments, are porphyrized and somewhat changed, though not strictly porphyries; and these porphyrized beds also frequently contain pebbles, and are therefore partially altered sediments".

One of the arguments that Emmons uses to prove the sedimentary nature of the Taconic and its derivation from the basal complex, is the presence of gold in the slates and schists, "which of course must have been commingled with the sediments at the time these rocks were deposited". * * * * * * * * "The gold exists mostly in the western belt of granite in the veins belonging to the hornblende and gneiss of the Blue Ridge."

Furthermore he claims to have discovered in his Lower Taconic sandstones and cherty beds at Troy and Zion (12 miles S. W. of Troy) in Montgomery county, 2 or 3 species of fossils.[1]

These fossils he describes as siliceous corals of a lenticular form, from the size of a pea to 2 inches in diameter. Two varieties are distinguished and named by him Paleotrochis (old messenger) major and Paleotrochis minor. He also reports to have found one or two specimens of an obscure bryozoon.

The following descriptive section in the ascending order of the rocks and beds, in which these fossils were found, is given :[2]

1. Talcose slates, passing into siliceous slates, and which are often obscurely brecciated.
2. Brecciated conglomerates, sometimes porphyrized.

[1] Geol. Rept. of the Midland counties of N. C., 1856, p. 60.
[2] Ibid, p. 61.

3. Slaty breccia, associated with hornstone.
4. Granular quartz, sometimes vitreous and filled with fossils and siliceous concretions of the size of almonds.
5. Slaty quartzite with very few fossils.
6. Slate without fossils.
7. White quartz, more or less vitrified, filled with fossils and concretions.
8. Jointed granular quartz, with only a few fossils.
9. Vitrified quartz without fossils.
10. Granular quartz, no fossils.

"The fossils also occur in the variety of quartz or quartzite known as burrhstone, and which is often porphyrized. The fossiliferous beds themselves are sometimes auriferous."

He is therefore disposed from these facts to place all the rocks, not decidedly igneous, or which he regarded as stratified (though in reality the apparent statification is but schistose lamination), with the sediments. He then correlates these rocks with the Taconic, the infrasilurian sediments of Massachusetts, mainly from their lithological characters, and the relations in which they are placed to the older rocks, and those which they sustain to each other. In North Carolina, he says, these rocks have been derived from syenitic granites, which he believes to belong to the primary or basal complex. He makes two divisions, the Lower Taconic and the Upper Taconic, the distinction between them, however, being less obvious in North Carolina, than in the northern equivalents.

THE LOWER TACONIC.

"*The Lower* series (Taconic) will contain the talcose slates, white and brown sandstone, or quartz, which is frequently vitrified or cherty, and the granular limestone and associated slates."[1]

The talc slate is made up of talc and fine grains of quartz. Color and lustre is silvery when chlorite is absent, and greenish when chlorite is present. When quartz predominates it becomes a friable sandstone.

The quartz rocks, white and brown sandstones, occur under the following varieties:

1. A fine grained coherent quartz.
2. A fine grained friable quartz.

[1]Geol. Rept. Midland Counties of N. C., 1856, p. 49.

3. A fine grained micaceous and talcose quartz.
4. Vitrified quartz or chert.
   (a) green, blue. (b) agatized.
5. A cherty or apparently porphyrized quartz, which contains feldspar, which decomposes and leaves a rough porous mass similar to burrh-stone.
6. Pebbly and semi-brecciated quartz.
7. Common brown quartz.

This rock is associated with the talcose slates, and is repeated two or three times; it frequently contains pebbles, and passes into hornstone, chert or flint.

The apparent vitrification he considers due to a chemical combination of the particles, or to a cause independent and distinct from heat.

"Agalmatolite" (pyrophyllite) also occurs in beds in this Lower Taconic series.

The limestone is associated with slate and quartz, and contains talc and tremolite.

The rocks of the Lower Taconic then are:

1. Beds of talcose slates. 2. Quartz rocks with their alternating series of talcose slates. 3. Beds of agalmatolite. 4. Limestone with its interlaminated slates.

THE UPPER TACONIC.

"The upper (series) will contain (in ascending order) the green clay slates novaculite, the argillaceous, and sometimes chloritic sandstones or grits, and the brecciated conglomerates."[1]

This division of the system is not very clearly marked, but the rocks regarded by Emmons as belonging to it in North Carolina are:

1. *The argillaceous or clay slates and subordinate beds.* Ordinary soft, greenish slates are the prevailing rocks. A red decomposed variety is mentioned as being common near Pittsboro, Chatham county. The subordinate beds are fine siliceous slates, passing into chert and hornstone. Color blue, purple and green.

2. *The chloritic and argillaceous sandstones* have an interme-

[1] Emmons: Geol. Report Midland Counties of N. C., 1856, p. 49.

diate composition between sandstone and slate. They are finer and more chloritic and among them are beds of conglomerate. These chloritic beds may be taken for trap, being greenish and tough, and besides like trap the broken strata exfoliate in concentric layers.

3. *The brecciated conglomerate* has an argillaceous or chloritic base. The mass is composed in the main of fragments of other rocks, mostly retaining an angular form. These fragments are sometimes as much as 2 feet long.

The clay slates and breccias, with their intermediate beds, are traversed by veins of milky quartz; these are sometimes auriferous, but usually barren.

The socalled quartzite of both the Upper and Lower Taconic is considered of such peculiarity that a separate chapter is devoted to its description. It is an uncrystallized (crypto-crystalline) quartz resembling gun-flint, also called flint, chert and hornstone. Color bluish-black, passing to purple, grayish, white and green; sometimes banded; texture fine when compared with the finest sandstone; translucent on the edges; fracture flat conchoidal; often porphyritic or porphyrized, and frequently the fresh fracture is dotted with small limpid crystals of quartz.

These quartzites are not confined to rocks of a particular age or given series. They seem to be distributed through formations of all ages and epochs. Emmons explains their origin rather from a chemical than from a metamorphic standpoint.[1]

KERR'S HURONIAN SYSTEM IN CENTRAL NORTH CAROLINA.[2]

Kerr recognizes five principal outcrops of the Huronian rocks. The one that corresponds to the central auriferous slate belt, and hence of interest here, lies on the west side of the Raleigh granite. "The bottom beds are argillaceous and talcoid; * * * * * * * three to four miles from Raleigh these slates become highly plumbaginous, * * and a heavy body of micaceous, white, slaty quartzites follows closely along the west side of the graphite. Alternations of argillaceous, talcoid and

[1]Geol. Rept. Midland Counties of N. C., p. 51.
[2]Report of the Geological Survey of North Carolina. 1875. vol. 1; pp. 131-139.

quartzitic beds continue for five or six miles, when they disappear beneath a narrow trough of Triassic sandstones, beyond which they emerge along an irregular, but approximately N. E. and S. W. line in the general central mineral bearing slate belt. * * * * * * * It is composed of siliceous slates and clay slates chiefly; the former being often brecciated and conglomerate, the pebbles sometimes a foot and upwards in diameter, frequently chloritic, and often passing into hornstone and chert and occasionally into quartzite. The clay slates are generally thin bedded, often shaly, grey, drab, banded, blue and frequently greenish from an admixture of chlorite; sometimes talcoid or hydro-micaceous; and very often they may be better described as conglomerate slates, being composed of flattened and differently colored soft, slaty fragments of all sizes, from minute particles to an inch and more in diameter. * * * * * * * * in Montgomery county, in a very heavy ledge of siliceous slates, occurs a siliceous conglomerate which is filled for hundreds of feet with very singular siliceous concretions, some of which Dr. Emmons has described under the name of Paleotrochis; but the rock for several miles, as well as at this particular locality, contains a multitude of rounded and ovoid masses from the smallest sizes to that of a hen's egg; showing the wide prevalence of conditions favorable to the operation of concretionary forces."

He also mentions the occurrence of beds of pyrophyllite, and the abundance of quartz veins. The strike is northeast and the dip is prevalently west at high angles.

"The belt is bounded on both sides by the Laurentian on which it lies unconformably, and from which its materials were derived. The stratigraphy therefore indicates the horizon of these rocks to be the Huronian, and lithology agrees well with that determination."

RESULTS OF MORE RECENT PETROGRAPHIC STUDIES.

THE SLATES AND SCHISTS.

One of the results of the present survey in this belt has been to identify at least the argillaceous, sericitic and chloritic schists

and slates with those of Emmons' Taconic and Kerr's Huronian. (The Monroe slates form an exception and will be spoken of later—p. 36). These rocks have in places been called schists, in others slates. Certainly a great number of the rocks have a true slaty cleavage, while others are more truly schistose, i. e. the laminae are not essentially parallel. These structural effects are due to the action of dynamic metamorphism on materials of different composition. The argillaceous types might more properly be called the slates (clay-slate, thon-schiefer, argyllite, phyllite) as they contain more uncrystalline matter, and possess a more definitely slaty structure. So also bedding planes are more easily distinguishable in these, if at all; and altogether their sedimentary or clastic origin is more evident. At the same time they are metamorphosed in varying degrees and possess many secondary cleavage structures. These slates often have a calcareous tendency in their composition, as exemplified by the numerous small calcite seams that intersect them and the coatings of calcite on their cleavage planes.

The term *talc* (*talcose*, *talcoid*) slate or schist, used by Emmons and Kerr, and generally by many other writers, is a mistaken one. It is true that it is perhaps an excusable mistake, for these slates and schists are often so soft and greasy that the resemblance to talc is very great. However, chemical analysis and other characteristics would place it in the class of hydro-muscovite or sericite, the percentage of magnesia being far too small for talc. Several analyses of type specimens of this rock from the Haile mine in Lancaster county, S. C., by Dr. Chas. Baskerville, show:

Analyses of Sericite Schist, Haile Mine, S. C.

	(4)	(5)
SiO_2	44.61%	61.02%
Al_2O_3	31.57	25.54
FeO	3.55	4.46
CaO	0.20	0.60
MgO	0.22	0.14
MnO	0.16	——
Na_2O	6.96	2.19
K_2O	6.97	1.81
H_2O	5.80	4.20
	100.04	99.96

The term that we shall therefore use as more appropriate is sericite schist. The true talc schists are very rare.

The chloritic schists are probably more truly crystalline schists, and are richer in accessory metamorphic minerals, such as garnet and epidote.

The argillaceous slates and sericite schists are often silicified; the clorite schists are not as a rule. This silicification exists in varying degrees up to a completeness which renders the rock so hard that it resists scratching with a knife. This subject will be referred to again in the discussion of the genesis of the gold ores (see p. 47).

The strike of the formation as a whole is generally N. E. and S. W., and the dip steeply to the N. W. These strikes and dips refer to the schistosity of the rocks, and not to bedding planes. In the separate descriptions of the mines, wherever the bedding of the slates could be determined, and the instances were rare, it is so stated.

In general the force producing schistosity and slaty cleavage appears to have acted downward from the northwest, producing normal faulting with but little deformation. No instance of reverse faulting was recorded.

Now, as to the origin of these schistose and slaty rocks; in part, it seems that they must be sedimentaries altered by dynamo- and hydro-metamorphism. The evidence of this is offered by several observations of bedding and banding extending across the schistosity, generally at a low angle, as for instance at the Bonnie Bell, Stewart, and Russell mines.

Their lamination or schistosity, however, is wholly the effect of shearing, produced by dynamo-metamorphism, and not bedding planes of stratigraphic structure, as both Emmons and Kerr supposed. The original bedding planes may correspond to certain of the present cleavage planes, i. e., lie parallel to them, but in that case the bedding structure has been obliterated. Schistosity must not be confounded with bedding.

It does not seem probable at the present stage of the investigation, that these slates have been derived from the granitic and

other more basic igneous masses lying on the west; for as noted further on, these are supposed to be later intrusive bosses.

That others of these schists, particularly the chloritic varieties, are metamorphosed, sheared eruptives seems equally probable; such for instance are the schists of the Jones, Parker, Mann Arrington, etc., mines. They are even porphyritic and brecciated in places. In fact Emmons hints at such rocks in his description of the Upper Taconic chloritic member, when he says "These beds may be mistaken for trap, being greenish and tough, and besides like trap, the broken strata exfoliate in concentric layers"[1] (p. 32). This subject will be recurred to later on.

THE MONROE SLATES.

At Monroe in Union County, a considerable area of truly bedded and but little indurated or metamorphosed slates was discovered. Very similar slates were later on found at the Parker mine, at the town of Albemarle, in Stanly county, and at the Sam Christian mine, in Montgomery county. Thus presumably they cover a large area in the southeastern portion of the "Carolina Slate Belt." In the fresh condition this slate is black, weathering to dark and light drab, greenish and even reddish in color. At the railroad station (Monroe) it lies in a low, gently undulating anticlinorium. Several hundred yards south of the depot the strike is N. 85° E., and the dip 30° S. E. At this point it is intersected by numerous small quartz fissures, from the thickness of a knife edge to 2 inches, striking north and south, and standing nearly vertical. At a point ¼ mile north of the depot it is finely banded and lies nearly horizontal. It has been quarried here for use as paving blocks in Monroe.

These slates were not recognized by either Emmons or Kerr. That they are of sedimentary origin and of later age than the slates and schists to the west and north can scarcely admit of doubt. They are reported to dip under the Jura Trias conglomerate at Polkton, about 20 miles east of Monroe, and might be looked upon as Lower Paleozoic; but the absence of fossils (at

[1]Geol. Rept. Midland Counties of N. C., 1856, p. 66.

least so far none have been found, though a careful search is certainly warranted) must, for the time being, place them provisionally in the Algonkian. They might appropriately be named the "Monroe" slates.

QUARTZ ROCKS—THE VOLCANIC SERIES.

The middle member of Emmons' Lower Taconic is the quartz rock (white and brown sandstone), which exists in many varieties.[1] The work of the present Survey did not discover any true granular quartzites, such as characterize the Cambrian (even in a metamorphosed state); and in fact, from Emmons' and Kerr's descriptions, their rocks of this class are rather fine-grained, thin-bedded, quartzose schists, and devitrified quartz or chert, often porphyrized and brecciated. It is probable that Emmons' fine-grained, talcose quartz corresponds to the silicified argyllites and schists (p. 31), whose origin is due to a later hydro-silicification.[2]

The crypto-crystalline varieties of quartz (flint, chert, hornstone, agatized, chalcedonic) are of especial interest, and warrant a careful consideration. It is again deplored in this connection that the present report did not allow the time for a microscopic study of the thin sections. Such cherty, flint-like masses have been described from the Sam Christian, Moratock, Silver Valley and Hoover Hill mines. It is at present the opinion that these rocks belong to the class of ancient (pre-Cambrian) acid volcanics, in many respects analagous to, and probably contemporaneous with, similar rocks of South Mountain in Maryland and Pennsylvania, whose discovery was first announced by the late Dr. Geo. H. Williams.[3] Miss Florence Bascom has described the origin, devitrification and structure of the acid types of these rocks.[4] Dr. Williams has outlined the general distribution of the ancient volcanic rocks along the eastern border of North America.[5] These rocks are analogous also to the hälleflintas and eurites of Southern Sweden, described as volcanic rocks by Nordenskjöld.

[1] Geol. Rept., Midland counties of N. C., 1856, p. 50.
[2] Ibid, p. 51.
[3] The Volcanic Rocks of the South Mts. in Pa. and Md. Am. Jour. Sci. xliv., Dec. 1892, pp. 482-496. Scientif. Amer., Jan. 14., 1893.
[4] Jour. Geology, Vol. 1, 1893, pp. 813 832.
[5] Ibid, Vol. 2, 1894, pp. 1-31.

They would also correspond to Hunt's pre-Cambrian petro-silex rocks, called by him the Arvonian, being below his Huronian.

The hornstones have every appearance of being acid feldspar quartz rocks, and will probably be found, on further study, to belong to the class of apo-rhyolites, a term introduced by Miss Bascom to denote a devitrified rhyolite. Emmons describes the type very well under the head of quartzite. (p. 32)[1] They resemble perfectly crypto-crystalline quartz, and on weathering present an earthy, yellowish surface. The color of the fresh rock is drab, bluish to almost black ; translucent on edges ; fracture flat conchoidal ; sometimes banded, showing flow structure, as described from the Silver Valley mine where the rock is locally called "gun flint." It often contains small crystals of metallic sulphurets, chiefly pyrite with some galena, chalcopyrite and blende.

From the Moratock mine a siliceous rock is described (p. 79) as a quartz porphyry, which at first sight resembles a compact, homogeneous hornstone, but which on close examination is found to be dotted with small, dark colored, glassy specks ; these are minute quartz crystals. The true porphyritic character of the rock is best illustrated in the weathered specimens, the feldspathic groundmass being decomposed and altered, leaving the quartz phenocrysts clearly outlined. The flow structure is also beautifully brought out in the weathered groundmass.

Emmons, in the description of his quartzite, says they are "often porphyritic or porphyrized, and frequently the fresh fracture is dotted with small limpid crystals of quartz." In the enumeration of the varieties of Lower Taconic quartzites (p. 30) he mentions[1] "a cherty and apparently porphyrized quartz, which contains feldspar, which decomposes and leaves a rough porous mass similar to burrhstone." Kerr says:[2] "In Montgomery county, in a very heavy ledge of siliceous slate, occurs a siliceous conglomerate which is filled for hundreds of feet with very singular, siliceous concretions, some of which Dr. Emmons has described under the name of Paleotrochis ; but the rock for

[1] Geol. Report, Midland Counties of N. C., 1856, p. 51.
[2] This Bulletin p. 33; and Geology of North Carolina, 1875, p. 132.

several miles, as well as at this particular locality, contains a multitude of rounded and ovoid masses, from the smallest sizes to that of a hen's egg, showing the wide prevalence of conditions favorable to the operation of concretionary forces." These gentlemen have without much doubt described the quartz porphyry of the Moratock mine.

It appears highly probable that at least some of these siliceous, pebbly concretions are spherulites. Whether they constitute Emmons' pebbly beds, from which he determined the sedimentary origin of his Taconic, is not known. However it is quite possible that they misled him in that direction. Certain it is that he says:[1] "I found, however, many beds among them (slates and associated rocks) which looked like sediments, were porphyrized and somewhat changed, though not strictly porphyries. I found, after much search too, beds which were unequivocally pebbly; and finally, to remove all doubt, I was fortunate in discovering that the porphyrized beds also frequently contained pebbles; proving most conclusively that they are sediments which were partially altered."

Thus he evidently mistook either the concretionary form of the weathered porphyry and felsite, or else the partially rounded felsite fragments in the accompanying pyroclastic breccias (which will be spoken of further on), for pebbles.

Prof. Marsh in 1867 made a short study of Emmons' Paletrochis,[2] and in his words: "An examination of the interior of several specimens clearly indicated that they were not corals, and as soon as microscopical specimens could be prepared, they were more carefully examined, but no trace of organic structure could be detected, the entire mass being evidently a fine grained quartz. The specimens examined were undoubtedly authentic examples of Paleotrochis, as some of them presented to the Yale cabinet by Prof. Dana, were sent to him by Prof. Emmons, and the rest were given to the writer by Prof. W. C. Kerr, the present State Geologist of North Carolina." * * * * * *

[1] Geol. Report, Midland counties of N. C., 1856, p. 47.
[2] Am. Jour. Sci. (2), vol. 45, 1868, p. 217.

"Admitting the inorganic nature of these remarkable forms, their origin becomes an interesting question, and it certainly is not easy to give a satisfactory explanation of it. They appear, however, to have some analogy with "cone in cone," which, as the writer has shown elsewhere,[1] is probably due to the action of pressure on concretionary structure when forming. In some respects the two are quite distinct, but evidence of pressure is clearly to be seen in both."

Kerr evidently agreed with Marsh as to the inorganic nature of the Paleotrochis, and Mr. C. D. Walcott, the director of the U. S. Geological Survey, entertains the same opinion.

According to both Emmons' and Kerr's descriptions, these peculiar forms appear to occur in the acid effusive rocks. In his descriptive section of the rocks which carry the Paleotrochis, Emmons names the following :[2]

Granular quartz, sometimes vitreous and filled with fossils and siliceous concretions of the size of almonds.
Slaty quartzite with very few fossils.
Slate without fossils.
White quartz more or less vitrified, filled with fossils and concretions.
Jointed granular quartz with only a few fossils.

And he says: "These fossils also occur in the variety of quartz or quartzite, which I have described as burrhstone, and which is often porphyrized."

An interesting point is suggested in the above succession of rocks, namely, that there was more than one volcanic outbreak, and during at least one period of inactivity slates were deposited.

These acid volcanics are accompanied by pyroclastic breccias and basic eruptives, which are usually schistose. The same succession is also common to the South Mountain region in Maryland and Pennsylvania. Such rocks are described under the head of the Parker, Sam Christian, Moratock, Hoover Hill, Jones and Parish mines. The basic rocks are usually of a dark green color, and are perhaps pyroxenic in composition; sometimes propyllitic; they cover large areas, and are often massive or only partly schistose; again they are largely sheared into schists. A

[1]Proc. Amer. Assoc. Adv. Sci., vol. 16, 1867, p. 135.
[2]Geol. Report, Midland counties of N. C., 1856, p. 61.

wide outcrop of this rock was followed from the Hoover Hill westward to the Jones, Parish, Silver Hill, and Silver Valley mines, and thence westward to near the Lexington granite belt, a distance of over 20 miles. It is quite probable that most of the *chloritic* schists, in this part of the Carolina slate belt, are of this nature.

The breccias consist of this basic material in which are imbedded angular fragments of the felsite (apo-rhyolite) or porphyry up to one foot in diameter. They are distinctly pyroclastic breccias and hence the basic rock, or porphyrite, as it may be provisionally called, is later than the quartz porphyries and rhyolites. This would agree with the generally accepted law of eruptions, i. e., from the normal to the acid to the basic types.

Emmons, in his description of the Upper Taconic, mentions brecciated conglomerates as the most remarkable mass of this division. As he states, "It has an argillaceous or chloritic base. The mass is composed in the main of fragments of other rocks, mostly retaining an angular form; but frequently, rounded and worn rocks are enclosed in the mass. The fragments are sometimes 18 inches and even 2 feet long." [1]

Kerr mentions "brecciated and conglomerate siliceous slates, the pebbles sometimes a foot and upwards in diameter, frequently chloritic and often passing into hornstone and chert, and occasionally into quartzite." [2]

That these rocks correspond to the above described pyroclastic breccias is at once evident.

These ancient volcanics have also been found covering large areas in Chatham and Orange counties, near the eastern edge of the Carolina slate belt, and fully 40 miles east of the region including the above described localities. During the summer of 1893, Dr. Geo. H. Williams in company with Prof. J. A. Holmes, made a reconnaisance trip through Chatham and Orange counties, the results of which are included in Dr Williams' paper on the distribution of the ancient volcanic rocks in eastern North America.[3] He says: "In a drive from San-

[1] Geol. Report Midland Counties of N. C. 1856, p. 67.
[2] Report of the Geol. Survey of N. C., Vol. I, 1875, p. 132.
[3] Journal of Geology, Vol. 2, 1894, pp. 1-32.

ford to Chapel Hill an abundance of the most typical ancient lavas, mostly of the acid type, was encountered. On the road from Sanford to Pittsboro purple felsites and porphyries showing spherulitic and beautiful flow structures and accompanied by pyroclastic breccias and tuffs, were met with two miles north of Deep river and were almost continuously exposed on Rocky river. Here devitrified acid glasses with chains of spherulitic and eutaxitic structure were collected, while beyond, as far as Bynum on Haw river, 4 miles northeast of Pittsboro, the only rocks seen were of the same general character. On the farm of Spence Taylor, Esq., in Pittsboro, a bright red porphyry with flow lines is exposed in so altered a condition that it can easily be cut into any form with a knife, though it still preserves all the details of its structure. * * * * * * Three-quarters of a mile beyond Pittsboro, on the Bynum road, there is a considerable exposure of a basic amygdaloid. South of Hackney's Cross roads there are other excellent exposures of the ancient rhyolite with finely developed spherulitic and flow structures. * * * * * * Another locality in the volcanic belt was visited on Morgan's run, about 2 miles south of Chapel Hill. Here are to be seen admirable exposures of volcanic flow and breccias with finer tuff deposits, which have been extensively sheared into slates by dynamic agency. Towards the east and north these rocks pass under the transgression of Newark sandstone. * * * * * * From still another locality at the Cross Road near the northern boundary of Chatham county, 15 miles southwest of Chapel Hill, Prof. Holmes informs me that specimens of undoubted volcanic rocks have recently been secured. He has also sent me, within the past month, a suite of similar specimens from Pace's Bridge, on Haw river, 3 miles above Bynum."

Since that time the same volcanics have been found at the Narrows of the Yadkin river, on the Deep river at Lockville, Chatham county, and for 5 or 6 miles northwest of Lockville. At the last two localities the masses are often brecciated and usually sheared into perfect crystalline chloritic schists.

It is of interest to note in the above descriptions of Dr. Williams, the occurrence, on the Taylor farm near Pittsboro, of

a bright red porphyry with flow lines, in so altered a conditon that it can be easily cut into any form with a knife. This is undoubtedly the same rock, and from the same locality, described by Emmons (p 31.) as a decomposed red variety of his Upper Taconic argillaceous or clay slate. [1]

CONCLUSIONS.

In this brief resume then, we can recognize Emmons' Taconic and Kerr's Huronian rocks of the central ore-bearing slate belt.

The bitter controversies regarding the Taconic question among geologists are well known, and need not be taken up here. It is sufficient to say that geologists by later and more detailed work and study have seen fit to differentiate various members of the old Taconic System in different parts of the country, and refer them to more definite horizons. Thus the granular quartz of Emmons' typical Taconic section in the Berkshire Hills of Massachusetts, has been found to be characterized by the Olenellus fauna of the Lower Cambrian; and the Berkshire or Stockbridge limestone by the Chazy-Trenton, and perhaps at its base by an Upper Cambrian fauna; and the original Lower Taconic slate of Emmons is correlated, by its stratigraphic position, with the Hudson shales.[2] In 1888, Walcott, in studying a section of these rocks in Newfoundland, placed, from paleontological evidences, the "Red Sandrock" series, the Georgia shale and slate series, the "Granular Quartz" and the "Upper Taconic" of Emmons beneath the Middle Cambrian or Parodoxides zone of the Atlantic coast.[3]

And so the rocks of the old Taconic or Huronian belt in North Carolina must also in time be differentiated and recorrelated, when they have been more carefully studied.

Along the extreme western edge of the State from Mitchell to Cherokee county, the quartzites, slates, limestones, and conglomerates (here also in a great measure sheared and metamorphosed) which constitute Kerr's western Huronian belt or "Chero-

[1] Geol. Rept. Midland Counties of N. C., 1856; p. 65.
[2] United States Geological Survey. Bulletin 81. Correlation Papers: Cambrian; by C. D. Walcott; 1891, p. 243.
[3] Ibid, p. 113.

kee Slates," have been referred to the "Ocoee"[1] by the recent work of the United States Geological Survey.

Emmons was in a measure quite correct in calling the Taconic rocks of central North Carolina the bottom sediments, and placing them below the Silurian. The absence of fossils in the slates, however, necessitates our going back still another step, and placing them below the Cambrian sediments, in the Algonkian, which VanHise has defined as including all recognizable pre-Cambrian clastics and their equivalent crystallines, the base of the Cambrian being placed at the Olenellus fauna.[2] Here the matter must rest until we can find fossils in the rocks, or verify the organic character of Emmons' Paleotrochis; or until we can trace the rocks into a terrane of known age. So also the pyroclastic volcanics must be looked upon as pre-Cambrian.

It is of interest also to note that here, as in other portions of eastern North America, the ancient volcanics occur in close proximity to the western edge of the Jura-Trias basin. Adopting Suess' theory of the formation of mountains, we may look upon this central belt of sheared and faulted slates as the levelled site of an ancient Atlantic mountain range; while the bordering Jura-Trias represents a transgression formed by the sunken block on the east. Early phases of this subsidence were accompanied by the exhibition of volcanic forces, which found outlets for their material.

THE GENESIS OF THE GOLD ORES.

This involves a consideration of (1) the nature of the deposits, (2) the causes of the formation of the spaces occupied by the ores, (3) the manner of their filling.

1. THE NATURE OF THE DEPOSITS.

From the descriptions of the various mines examined in this belt it is evident that the gold ores exist in two principal structural forms, namely as quartz fissure veins, and as impregnations,

[1] The age of the "Ocoee" is still indefinite, and may be anywhere from the Algonkian to the Carboniferous.

[2] United States Geological Survey. Bulletin 86. Correlation Papers: Archean—Algonkian, p. 495.

lenticular, stringerform and irregular dissemminations in the country schists and slates.

The fissure veins in the slates and schists are generally difficult to distinguish as such. Their structure is much more evident in the granitic and other eruptive rocks. In the schists the larger regular quartz lodes lie apparently interlaminated in the country, or have the appearance of lenticular intercalations. However, even here they can usually be shown to intersect the schistosity, generally at a very low angle (as indicated at the Rocky River, Burns, and Mann Arrington mines). Such fissures have, as is usually the case, irregular boundaries, swelling and pinching; and it is also noticeable that they have on a large scale a lenticular structure, at least in linear extent (Rocky River mine). Certain it is that clean cut veinlets of quartz and calcite do occur, distinctly intersecting the cleavage and schistosity (as seen at the Bonnie Bell, Howie, and Moore mines). The Monroe slates also contain true quartz fissure veinlets. (See p. 36.)

The more usual mode of occurence of the ores is as small lenticular and stringerform bodies of auriferous, sulphuretted quartz, and as lenticular and irregular disseminations of sulphurets in the country slates and schists, which are usually silicified, to some extent at least. Such are the Scandinavian "fahlbands", which are described as belts of schists impregnated with sulphides.

Very often the slaty walling of a quartz body is impregnated for some distance with auriferous sulphurets, (as at the Rocky River, Buffalo and other mines). Again in some cases there is apparently no distinct quartz lead whatever, but the slates themselves are pyritic over certain widths and constitute the ore bodies (as at the Russell, Howie, Bonnie Bell, and other mines).

2. THE CAUSES OF THE FORMATION OF THE SPACES OCCUPIED BY THE ORE.

No instances of metasomatic (substitution or replacement) formation of the ores has been observed. They must therefore have found open spaces waiting for their deposition. Furthermore, it is evident that the origin of the ores was not contemporaneous with that of the schists, but later; this will be spoken

of again, (p. 51). The slates and schists are everywhere cleaved and sheared, the usual strike being N. 20° to 55° E., and the dip steeply to the N. W. Observations show that the resultant dynamic force which induced this structure, acted as a rule from the northwest downward, developing normal faulting, with but slight compression. Unfortunately opportunities did not allow of observations which showed direct illustrations of faulting, but it is certainly reasonable to suppose that dislocation must have generally taken place, if but with a very minute throw. And it is accepted that this dislocation, on larger and smaller scales, produced the *spaces of dicission* as Posepny calls them,[1] which were afterwards filled with the ore bearing solutions.

Certain maximum lines of faulting were developed which made room for the larger fissure veins, on either side of which the smaller dislocations formed belts of variable width. Or, where the tension, compression, resistance, etc., were more uniform, larger fissures were absent altogether. The existence of small, isolated impregnations of crystalline sulphurets in the slates may possibly have another explanation. But the lenticular and stringerform quartz bodies, even those of minute size, will scarcely admit of any other. The main course of these belts is N. 20° to 55° E., and the dip is from 55° to 85° N. W. Isolated instances of crossfissuring occur (Ore Hill; the Phifer mine; and the Howie mine, where cross fissures are filled with "reibungs-breccia,") but these are rare occurrences. Indeed it seems reasonable to suppose that in such a sericitic, chloritic, or kaolinitic material as these slates and schists are composed of the chief yielding planes should have been in parallel directions to the cleavage.

The frequent diabase dikes, which exist throughout the region, occupy fissures which strike usually northwest, across the general schistosity of the country, and intersect the ore fissure. These dikes are usually of considerable width, from a few feet to

[1]The Genesis of Ore Deposits, by F. Posepny. Trans. Am. Inst. of Mining Engineers, 1893, vol. 23, pp. 197-370.

as much as 150 feet. They may be looked upon as paraclastic[1] fissures, while the ore fissures are diaclastic.

THE MANNER OF FILLING THE FISSURE OPENINGS.

The theories of the filling of open spaces (spaces of dicission and spaces of dissolution) by their xenogenous[2] mineral contents are so manifold, and they have been the subject of so much controversy among geologists and mining engineers, that care must be exercised in their application. Recently several most admirable treatises have appeared on this subject, chief among them being "The Genesis of Ore Deposits," by F. Posepny (Trans. Amer. Inst. Mining Eng., Vol. 23, 1893, pp. 197-370); and "The Ore Deposits of the United States," by Jas. F. Kemp, (published by the Scientific Publishing Co., N. Y., 1893, second ed., 1894). Work of great excellence and value has also been published in the monographs of the United States Geological Survey, notably by Becker, Emmons, Curtis, Hague, etc.

We can look upon the manner of filling of the spaces of dicission formed by faulting and fracturing, in the area under consideration, in no other way than by the ascension of mineral bearing waters from below. This is the ascension theory upon which Posepny, very properly, lays such great stress, though he is probably inclined to make unduly general application of the same.

And we connect the origin of these deep seated waters with the last stages of the volcanic activity that was general along this line of disturabnce, the so-called solfataric, mofetti and fumarole stages.

Heated carbonated, alkaline waters are capable of taking silica and metallic elements and sulphides into solution. Such waters, perhaps in a very dilute condition, ascended and circulated through the open fissures and spaces, and deposited their mineral contents on the walls, by virtue of relief of pressure, reduction of temperature, and perhaps of certain chemical reactions. The frequent silicification of the

[1] *Paraclastic* dike fissures are such as were opened along entirely new lines, while *diaclastic* ore fissures are such as were opened along cleavage lines which already existed.
[2] Minerals foreign to the rocks contiguous to the vein, i. e. brought up from below.

slates and schists has been noted, and must be ascribed to this permeation by silicified waters. Mr. Becker supposed, very reasonably, that there might be some direct connection between this fact and the richness of the ores, i. e. the highly silicified schists might be also more highly charged with metallic contents. Close inquiry into this, however, has shown us that they are not necessarily richer than the softer varieties, when such are impregnated with xenogenous minerals. And it therefore seems that the main silicification went on independently, it may have been at the same time with the deposition of metallic minerals or subsequently; it was probably more of a chemical than a mechanical action, i. e. certain portions of the original country rock may have been so composed chemically as to have permitted of partial replacement by silicic acid, while others did not.

In two instances only (Burns and Howie mines) was free gold found directly in the soft sericitic schist, which was apparantly entirely unsilicified and free from quartz. However, the absence of quartz or silicification in even an incipient stage cannot be regarded as favorable to the metallic richness of the ore bodies.

The diabase dikes which occur in this region appear in general to have exercised a notably favorble influence on the richness of the ore bodies. The ores are often richer in the vicinity of the dikes. At the Haile mine in Lancaster county, S. C., this is very marked.[1] Presumably the formation of these dike fissures has stimulated and intensified the circulation of the mineral bearing waters below, and it is even probable that these waters may have derived part of their metallic contents from the diabasic magma, which is often slightly pyritic, and has in one case at least been found to contain free gold.[2]

The impregnations of small isolated crystals, up to ¼ inch cube, or fine crystalline aggregates of sulphurets, usually pyrite, in the soft, unsilicified slates, within the limits of the ore belt and at a distance from the same, still remains to be explained.

[1] The Geology of the Haile Mine, S. C., by A. Thies and A. Mezger, Trans. Amer. Inst. Min. Engrs., 1890, Vol. xix. pp. 595-601.

[2] Ores of North Carolina, Raleigh, 1887. Appendix B. "On some Peculiarities in the Occurence of gold in N. C.", by W. C. Kerr, pp. 327-328.; also Trans. Amer. Inst. Min. Engrs., Vol. x., 1882, p. 475.

One explanation would be that the mineral solutions percolated through minute, pre-existing pores in the country rock in which they deposited their contents. The only other way in which to account for their presence would be by a metasomatic change or replacement, such as suggested by Becker for the genisis of pyritic impregnations in the altered rocks of the Comstock Lode in Nevada, by the action of hydrosulphuric acid solutions on ferruginous bisilicates.[1]

The presence of free gold in the soft slates at the Burns and Howie mines, above alluded to, might be explained as a residuum from such auriferous pyrites, the iron sulphide having been oxidized and leached out.

Mr. Becker has pointed out the tendency to successive deposition from solutions reaching complete saturation for separate minerals at different points in space.[2] This explanation may be applicable to the local deposition of free gold, unaccompanied by quartz or pyrite, such as is seen in the fine coatings on the cleavage planes of the unaltered slates at the Howie mine.

As a rule the richer ore bodies exist as shoots or chimneys, which have a pitch of their own in the vein, and which must represent the main course of maximum circulation. The position of these shoots may bear some direct relation to the laws of fissuring.

Posepny is inclined to accept "crustification"[3] phenomena as an infallible proof of the ascension theory of vein filling. While this may be disputed, yet in connection with the other facts above pointed out in regard to the deposits under consideration, incrustation can only furnish additional evidence of the manner and sequence of filling.

Several observations of incrustation were made; probably the best example was met with at the Moore mine in Union county, as shown in the accompanying figure (Fig. 1).

[1] Geology of the Comstock Lode and Washoe District; by George F. Becker; United States Geological Survey; Monograph III, 1882, p. 210.
[2] United States Geological Survey; Mineral Resources of the United States; 1892, p. 150.
[3] Mineral deposits on the walls of fissure veins. See Posepny's *Genesis of Ore Deposits*, 1895, p. 11.

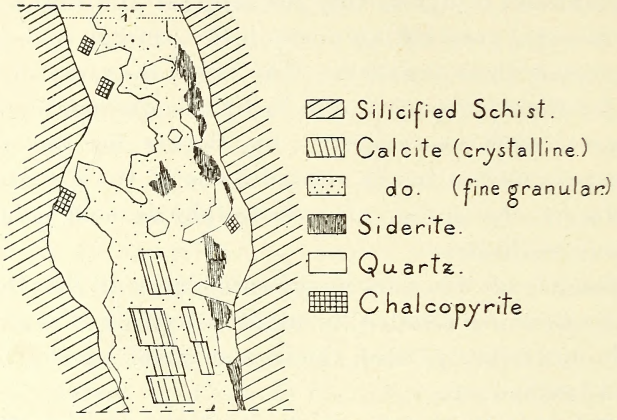


FIG. 1.—Illustrating crustification in a specimen from the Moore mine, Union Co.

It illustrates a narrow fissure containing quartz well crystallized along both walls, with its vertical axis at right angles to the same. The interior is filled with fine granular calcite and some well crystallized calcite rhombohedrons; small specks of a light brown mineral, probably siderite, are distributed in the calcite and against the quartz. The quartz contains crystals of chalcopyrite. Thus, the quartz and chalcopyrite were the first minerals to crystallize out of the solutions, and were deposited in layers or bands on both walls; following these came the siderite and calcite.

In conclusion of this part of the subject it may be pointed out that Emmons' supposition that the gold in the slates and schists is of sedimentary origin (p. 29) is thoroughly untenable. It is true that there is generally in the South, beyond the zone of glaciation, an upper layer of decomposed rock, varying from a few feet to 150 feet in depth. This may be in instances subject to motion and rearrangement whereby the broken down quartz veins, with their gold, may be concentrated, in places forming placer deposits; or the gold may even be distributed quite generally through such a secondary mass (Parker, and Portis mines). But Emmons could not have referred to this alone, for his assertion is too broad.[1]

[1] Geol. Report, Midland counties of N. C. 1856, pp. 57, 64.

AGE OF THE ORE DEPOSITS.

The filling of the dicission spaces took place subsequent to the force producing schistosity. This appears a *fortiori* from what has been said regarding the causes of the formation of the spaces occupied by the ores, and the manner of filling. But an additional proof is offered by the fact that in almost every instance fragments of the slate and schist country rock may be found included in the quartz.

In the extreme southwestern part of the State, Cherokee county, the auriferous quartz veins occur in the Ocoee rocks, and are therefore of Algonkian or Paleozoic age. However, this region is too distant to be used as positive evidence in correlation here. There may have been two eras of vein formation.

The investigations of the Jura-Trias basal conglomerates prove that the origin of the gold must be pre Jura-Triassic. The presence of gold bearing fissure veins in the Monroe slates (p. 36) shows that their age must be post Algonkian or possibly late Algonkian. The existence of ore bodies in the Pre-Cambrian volcanic rocks furnishes additional ground for this statement.

CHAPTER IV.

DESCRIPTION OF THE ORE DEPOSITS AND MINES IN THE CAROLINA SLATE BELT.

MINES IN GRANVILLE AND PERSON COUNTIES.

The belt of copper ores in Granville and Person counties[1] belong here geologically, although it is not our purpose to discuss the copper deposits of this section at any length, except as they may be relative to the precious metals.

All of these copper ores contain both gold and silver, but not in large proportions. The following assays of ore from the Yancey mine, in Person county, will indicate their general character:

Assays, Auriferous Copper Ores, Yancey Mine, Person County.

	(6)	(7)	(8)
Gold, per ton	$ 2.07	$ 2.07	$ 2.07
Silver	8.66	6.98	.65
Total	$ 10.73	$ 9 05	$ 2.72
Copper, per cent	48.17%	26 16%	31.14%

The above cited contents of precious metals is not likely to cut a large figure in the gold mining industry of this section, but they may form a most important item of profit in a well conducted metallurgical treatment of these ores for copper.

It must be premised that neither exploration nor exploitation is advanced enough to allow of more than approximate statements.

Dr. Emmons, in his report,[2] estimated the copper belt to be 5 miles in length, but later examinations make it more than twice that length, for it makes its appearance considerably to the north of the Virginia line, and extends southwest to and even beyond the Yancey mine in Person county.

The belt is almost entirely confined to a ridge, which, with some bends, runs in a course S. 15° W., some thirty miles, nearly to Durham. This ridge, although of no great height, is a some-

[1] Ores of North Carolina. Geological Survey of N. C., by W. C. Kerr and Geo. B. Hanna, 1887, p. 214.
[2] Geology of the Midland Counties of N. C., 1856, pp. 344 et. seq.

what prominent feature in the landscape, and slopes very gradually both to the eastward and westward, and is everywhere strewn with abundant fragments from broken down quartz veins or seams, The schists are very hard and silicified, and the adjacent matter sometimes shades gradually into ore. The strike is from N. 10° to 20° E., and the dip 70° to 80° S. E.

The veins are approximately conformable to the schistosity, and lenticular in structure, varying from a few inches to as much as 14 feet in thickness. The different veins cannot be brought into one alignment, but occupy a belt which at several points is about one mile wide. The ore is quartz, containing chiefly "gray copper" (chalcocite) and bornite, with some red oxide, carbonates, and rarely native copper; chalcopyrite and pyrite occur in small quantities.

The principal mines of this region are the Royster (or Blue Wing), Holloway, Mastodon, Buckeye, Pool, Gillis, Copper World and Yancey; only the Royster, Gillis and Yancey mines have been largely worked; and at present these are idle.

ALAMANCE, ORANGE AND CHATHAM COUNTIES.

Gold has been found in these counties but no attempts at serious mining have ever been made. Some of the copper ores of Chatham county are auriferous, and may be mentioned in this connection.

In Orange county the Robeson mine (near the old Patterson mine), 12 miles northwest of Chapel Hill, was discovered in 1890. The ore body is a quartz vein, striking northeast and dipping 30° northwest. The outcrop has been traced for a distance of 4 miles northeast and several hundred yards southwest. During the fall of 1895, a prospect shaft was sunk 30 feet on the underlay, and the vein widened from 6 inches on the surface to 22 inches at the bottom of the shaft. The quartz is cellular, vitreous to saccharoidal, and has a good appearance. Various assays have shown from $6 to $52 per ton. Development work is now in progress here, under the direction of Mr. R. E. Lyon, of Durham, N. C.

MOORE COUNTY.

The mines are situated in the northern and western part of the county, not far from the northwest boundary of the Jura-Trias basin.

The Belle Mine is in the northern part of the county, 8 miles N. N. W. of Carthage.

The country rock is chloritic schist, sometimes garnetiferous. Small calcite seams also occur. The rock has much the appearance of being a schistose, metamorphosed eruptive; propyllitic alterations were observed. The strike is N. 55° E., and the dip 75° N. W. In the upper part of one of the old shafts the schists were observed to bend over with the slope of the hill, from the normal dip to an anomalous S. E. dip, which was as great as 45° near the surface.

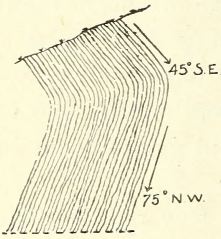


Fig. 2, showing bending of schists, Belle mine.

The mine is abandoned and no ore was visible when the property was visited in 1894. It is stated that the mineralized schists themselves constitute the ore, which exists in several narrow belts containing siliceous seams from ⅛ to 4 inches in thickness. Mr. Richard Williams, the former superintendent, reports that the pay streak was from 4 to 8 inches wide, lying against the foot wall, and that 1½ to 2 feet of the material in the foot wall side was mined and milled, yielding as much as $30 per ton. The entire vein matter, averaging fully 4 feet in width will run $12 per ton. In the course of a professional examination [1] a rigid sampling of the entire ore body explored in the 75 foot level was made. The assays for the two drifts gave the following results:

Assay, Gold Ores, Belle Mine, Moore County.

	(9)	(10)
Gold, per ton	$13.95	$11.37
Silver, "	.62	.35
	$14.57	$11.72

There is very little sulphuret present, and the free gold is very "leafy", which has caused great difficulty in working the ores

[1] By Mr. G. B. Hanna.

by the ordinary modes of amalgamation. In the northwestern part of the county is a group of 9 or 10 mines, comprised in an area 2 miles wide from northwest to southeast, and 6 miles long from northeast to southwest. These limits indicate the productive part, but the actual auriferous area is considerably more extended.

The Burns (or Burns and Alred) Mine is situated 11 miles W. N. W. from Carthage on Cabin creek. The freehold and land tracts comprise more than 300 acres.

The country rock is a sericitic, chloritic schist, in part silicified. The strike is N. 20° E., and the dip 55° N. W.; the joint planes dip 35° S. E.

These schists are filled with quartz stringers and lenticles. It is difficult to say what is ore and what is not, for the rock is everywhere auriferous, though not everywhere capable of being profitably worked.

It is mined in large opencuts, 20 to 100 feet wide, to a depth of about 50 feet. The cuts extend along the strike for a distance of about $\frac{1}{5}$ mile. This is on Moody Hill; some work has also been done on Brown Hill.

The selection of places for exploitation has been almost exclusively determined by the results of mill runs of the ore, or by panning; and while this method of work has been wasteful in some respects, it was probably the best method available. The cuts are scattered about promiscuously, without much evident connection or relation, and are usually very irregular in outline.

It is stated that the average ore yields $2.50 to $3 per ton, free gold; and at intervals schists of high grade have been found, and may be encountered at any time.

Iron sulphurets also occur in the schists, but they have not yet been treated, as little, if any, of the work extends below the water level. The rock is also intersected by quartz veins in all directions, but they are presumably barren. Some of the quartz contains included fragments of the country schist. Several interesting specimens were exhibited by the superintendent at the time of our visit. These were small pieces of the soft, unsilicified schist, also free from quartz stringers, containing free gold.

The mill house is equipped with 5 Crawford mills, which treat 8 tons of ore per 24 hours. Three of these were in operation (Nov., 1894).[1] This mine has been operated for more than 40 years. Under the old, and for the most part successful, methods the work was on a small scale, the machinery inexpensive, the capital small, the management economical, and the attention to business was unremitting. And these circumstances will not unfairly indicate the conditions of successful work for all the mines of this group in the future.

The Cagle Mine is situated about ¾-mile north of the Burns, and the country rock and ore are similar. The strike is N. 27° E., and the dip 55° N W. The mine was formerly operated by a series of inclined shafts, on the dip, to a depth of 160 feet.

The results of a series of assays of the ore from this mine show:

Assays, Gold Ores, Cagle Mine, Moore County.

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Gold	$5.17	$39.27	$26.62	$7.75	$6.20	$7.23	$47.54	$4.14
Silver	.18	.70	.66	trace.	trace.	.06	1.10	.13
	$5.35	$39.97	$27.28	$7.75	$6.20	$7.29	$48.64	$4.27

The Clegg Mine is ¼ mile west of the Cagle, on the west side of Cabin creek. It has the same character of ore, though the body is larger, and of relatively lower grade. It has been worked by open cuts.

The Brown Mine is on the northeast edge of the district, on the road from Moffitt's to Richardson's mill. It has been worked for a distance of 300 yards, and to a depth of 40 or 50 feet. The dip is very flat; the ore body is three feet thick, but the "pay streak" was a comparatively narrow seam of rich quartz, which, it is stated, finally narrowed down to such limits that it could not be profitably worked.

RANDOLPH COUNTY.

The Hoover Hill Mine[2] is situated about 17 miles a little east of south from High Point, on the waters of the Uharie river, and on the western flank of the northern extension of the Uharie

[1] In 1895 this plant was abolished by the Cabin Creek Mining Co., and a ten stamp mill with concentrating machinery erected, which it is proposed to use in connection with a cyanide treatment.

[2] Geological Report of the Midland Counties of North Carolina. E. Emmons, 1856, p. 139.

mountains. The mine has only been worked spasmodically during late years. Unfortunately the water was up on the day when recently visited, and the underground workings were not open to examination.

The country rock is a decomposed basic eruptive, which is partially brecciated, the included fragments being hornstone. Masses of hornstone, containing sulphurets, were also found, resembling that of the Silver Valley mine (p. 66). As at the Silver Valley and Silver Hill mines the basic rock is somewhat schistose in structure. It is probably a quartz porphyrite. Certain more or less definite belts of this rock are intersected by innumerable small reticulated quartz veins, from less than one inch to one foot in thickness, and this is the material that constitutes the ore. The weathered outcrops were extraordinarily rich and gave the mine its early fame. At greater depths the gold is invariably associated with the quartz seams, though quartz sometimes occurs without enriching the ore body. Sulphurets (iron pyrites) are present to the extent of about 3 per cent.

The principal ore body is known as the "Briols shoot," entered by the Briols and Gallimore shafts, the former being 350 feet deep. The ore body at this depth was large; its width was 12 feet, and its length 70 feet or more; it was worth $8 to $10 per ton. At no great distance from the Briols, six other bodies lying quite closely together have been worked by the Hawkins shaft.

The Wilson Kindley Mine is situated ½ mile southwest from the Hoover Hill, and the formation is like that of the latter mine.

The Jones (or Keystone) Mine[1] is situated 18 miles E. S. E. from Lexington and 12 miles S. S. E. from Thomasville. The country rock represents a very schistose phase of the brecciated porphyrite found at the Hoover Hill mines. It is very soft and decomposed, so that the iron sulphuret, with which the rock is charged, has given rise to pure limonite which has filled the joints and cross seams, and in fact stained the whole mass a reddish brown color. The strike of the schistosity is N. 45° E.,

[1] Geological Report of the Midland Counties of North Carolina. E. Emmons, 1856; pp. 131, 132.

dipping 80° N. W. Besides the suiphurets, this schistose rock is filled with fine stringers of quartz. The ore bodies consist of this quartzose, pyritic mass.

Gold is universally present in the soil of the region, but mining is confined to certain well known belts, which are more richly charged with it. Occasional horses (or "bars") are found charged with finely disseminated iron pyrite, and being as yet slightly altered, are still solid and firm; these (unless very rich) are usually avoided from the comparative difficulty both of mining and milling. Two of these belts have gained especial prominence, one being 50 feet and the other 110 feet wide. But there are numerous openings on every part of the tract, from every one of which auriferous material may be obtained. The portions which are comparatively barren are easily recognized and readily avoided. The mine is a series of open quarries. The tract is everywhere cut by gulches, which allow easy access and cheap entry into the ore bodies, and at the same time facilitate transportation by gravity tramways, to the mill.

The character, the occurrence, and the distribution of the ore, are such, that new bodies, equal in value to any that have been hitherto worked, may at any time be exposed.

The disintegrated condition of the rock allows of mining at a marvelously cheap rate, frequently not exceeding 15 cents per ton of ore delivered in the mill-house.

The material is low grade, but it changes perpetually in its contents, and bodies of relatively high grade material may be met with at any time, but the extent of these rich seams is limited. The assays[1] give:

Assays of Gold Ores, Jones Mine, Randolph County.

	(19)	(20)	(21)	(22)	(23)
Gold per ton	$ 3.10	$ 6.20	$ 2.58	$ 3.10	$ 2.07
Silver " "	.10	trace	trace	.03	trace
	$ 3.20	$ 6.20	$ 2.58	$ 3.10	$ 2.07
	(24)	(25)	(26)	(27)	(28)
Gold per ton	$ 28.94	$ 4.15	$ 2.07	$ 4.15	$ 4.82
Silver " "	trace	trace	trace	.13	.13
	$ 28.94	$ 4.15	$ 2.07	$ 4.28	$ 4.95
	(29)	(30)	(31)	(32)	(33)
Gold per ton	$ 4.14	$ 3.10	$ 2.89	$ 4.14	$ 3.61
Silver " "	trace	trace	trace	trace	trace
	$ 4.14	$ 3.10	$ 2.89	$ 4.14	$ 3.61

[1] By G. B. Hanna.

Strict averages of large bodies of accumulated material, or reserves easily accessible, gave fairly uniform results, so that it may be said with fairness that the average value of working bodies will not fall under $3.00 per ton.

Sample No. 24 above was taken by accident from a place which did not in the slightest degree indicate any superior value.

Mining has been carried on here for two generations, and as long as the rich shoots and the concentrated material lasted, it was profitable, but when the resources worked down to the low grade ore, the old methods were no longer applicable, and the work became fitful.

In the open cut where the present (Nov. 1, 1894) operations are being carried on, the width of the ore bearing schists is 12 to 15 feet. A ten stamp mill stands on the property and the ore is stated to mill $2.00 per ton.

One of the prime conditions of success with low grade mine stuff of this character is the handling of large quantities. A combination hydraulicking and milling process (Dahlonega method) might be applicable here. The nearest supply of water is the Uharie river, a bold stream, some 2 miles away, but at a lower level.

The Parish Mine, now abandoned and inaccessible, is situated about ¾ mile southwest from the Jones. The country rock is similar to that at Hoover Hill, though more decomposed. It is schistose in structure and shows brecciation. The ore body is mainly actinolite which is auriferous.

The Lafflin (or Herring), and Delft Mines are situated in the vicinity of the Jones, and are similar to that in the character of their ore bodies.

The Winningham and Slack mines are in Randolph county, two and a half miles south of Ashboro.

The Davis Mountain Mine is four miles southwest of Ashboro.

The Sawyer Mine is five miles northwest of Ashboro. At this locality the ore body is massive and consists of parallel belts of silicified schists in an advanced stage of disintegration, and sometimes forming a body of fine, loosely coherent sand. These

schists are auriferous, and the workable bodies are sufficiently near each other to be worked at the same time.

The Winslow is five miles southwest of Ashboro.

The Uharie Mine is a short distance to the northeast of the Russell mine, (see p. 74), just over the line in Randolph county. The formation is for the most part the same as at the Russell, and calls for no detailed description. The entire mass of gold bearing schists is believed to carry 1½ per cent. of pyrites. Unlike the Russell mine, the former work here was underground. The shaft was sunk to a depth of 170 feet.

DAVIDSON COUNTY.

The Emmons (or Davidson) Mine is situated 15 miles southeast of Lexington. The country rock is a soft chloritic schist, striking N. 22° to 31° E., and dipping 40° N. W. These schists contain small quartz veins, approximately conformable with the lamination, from a few inches up to one foot in thickness, and the whole material is mineralized with sulphurets (mainly chalcopyrite, with some galena, sphalerite, and pyrite). Siderite and chlorite occur as gangue minerals. The total thickness of the ore body is stated to be from 3 to 8 feet. The ore shoots pitch to the southwest. The ore is only slightly auriferous and has been worked entirely for its copper contents. The mine is entered by two shafts 680 feet apart, and both in the lode. The deepest shaft is 416 feet deep on the incline. Levels occur at 200, 280, 350 and 410 feet. It was reopened and worked several years after the war by a Baltimore company. The Hunt and Douglas (old) process was used here successfully for a long period. The available supply of ore was exhausted, according to a statement of James E. Clayton, then superintendent, and the mine closed down. In 1885 and 1886 it was again operated for a short time.

The Cid Mine is 1¼ miles northeast of the Emmons. The appearance of she schists and the general character of the ore resemble the conditions at the Emmons. It carried from the start rich copper ores; chalcopyrite, with black oxide and other surface alterations. The surface ore carried from 5 to 15 ounces

of silver, with a little gold (for which it was first worked, but without much success).

An underlay shaft was sunk 100 feet, when, from some unascertained cause, work was stopped.

The Silver Hill Mine[1] is situated about 10 miles southeast from Lexington. The country rock is chloritic schist, striking about N. 35° E., and dipping 57° N. W. Specimens of an eruptive dike rock were found, apparently pyroxenic in composition; and other specimens of the same rock show a fibrous, asbestos-like mineral; still other specimens exhibit a fine grained, silicified phase. One large piece showed a contact between the coarse eruptive and the country schists, along which occurred a coating of zinc blende. The dike rock also contains fragments of schist. The schists are impregnated with sulphurets (pyrite up to ¼″ cube, and also galenite and sphalerite).

The two principal veins or lodes are know as the "East" and the "West;" they are parallel and about 28 feet apart on the outcrop. The strike is N. E. and S. W., and the dip is N. W., in the vicinity of 45°.

The prevailing appearance of the upper part of these lodes, and their accompaniments, is a yellowish white, decomposed, material, varying from hard rock to rotten schist and soft clay, and with the mineral matter dispersed through it, and not readily distinguishable.

The gossan is composed of the usual decomposed sulphurets and was at first worked for gold. The treatment of the ores for gold, however, did not continue long, for the real character of the mine speedily disclosed itself. Below the water level the ores become a complex mixture of sulphurets, chiefly galena and zinc blende, with some chalcopyrite and pyrite, and the principal precious metal content is silver.

From the imperfect records of the mine now accessible it is believed to have been discovered in 1838. It has been more extensively worked (the Gold Hill excepted) than any other

[1] Geological Report of the Midland Counties of North Carolina. E. Emmons, 1856, pp. 183-193.

mine in North Carolina. The last work was done about 12 years ago, since when the mine has been closed and inaccessible.

The mine, during the thirty years of its active work, was practiced on by all kinds of "process" mongers, and the grounds and buildings are a museum of old and nondescript machinery and metallurgical appliances. A mechanical separation of the galena and blende by buddles and similar concentrating machinery was probably the nearest to success of any of the methods adopted here; but assays of the tailings and slimes show a great waste of valuable constituents. The ore was for a time used without separation of the galena and blende in making white paint, and served, it is believed, an admirable purpose. The ore is essentially adapted to a smelting process in combination with copper ores, such as was successfully tried some 3 years ago on similar ores from the Silver Valley mine. (See p. 66).

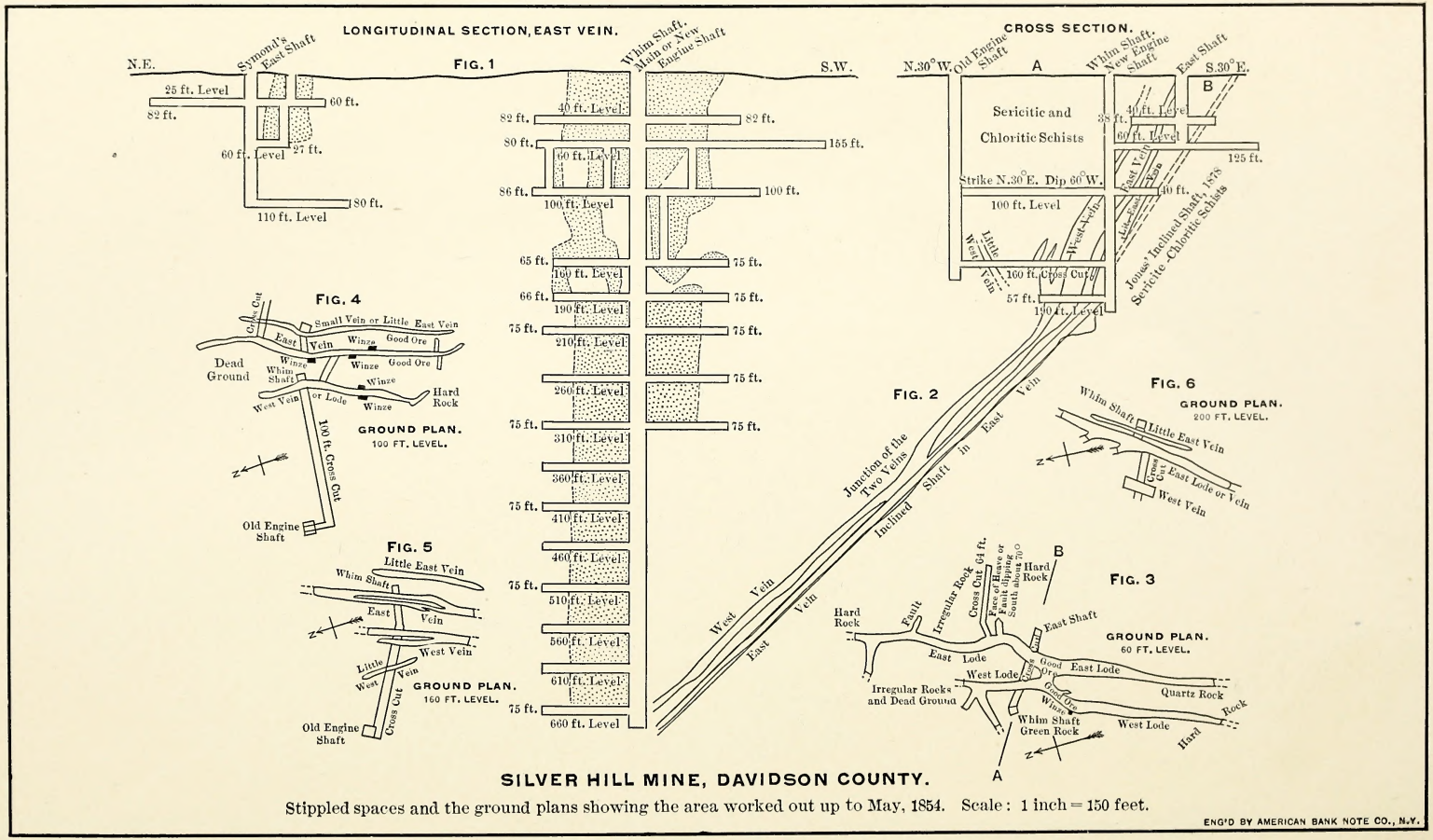
Plates Nos. II and III show all the important underground features. Down to the 200 foot level the drawings are from actual surveys by R. C. Taylor and Jas. V. Symonds; below that point they are made from notes and statements by the old superintendents and underground bosses, especially Mr. James Prim, and are to be regarded as only approximately correct. No records of a survey of this lower part of the mine exists.

Much the greater part of the ore has been taken out by the Engine shaft (at first known as the Whim shaft). Down to 200 feet this shaft was vertical; from the 190 foot level of this vertical shaft an inclined shaft was sunk to a nominal depth of 660 feet; this incline was in the back or east vein, and in the main followed the dip. Both veins were worked from these shafts, as shown in plate No. II, in the vertical section through the engine shaft.

The mine has been more or less prospected for about 700 feet of its entire length, but the vein formation extends a much greater distance, as is shown by the following assay of ore from the north extension:

Assay, gold ore, north extension, Silver Hill, Davidson county.

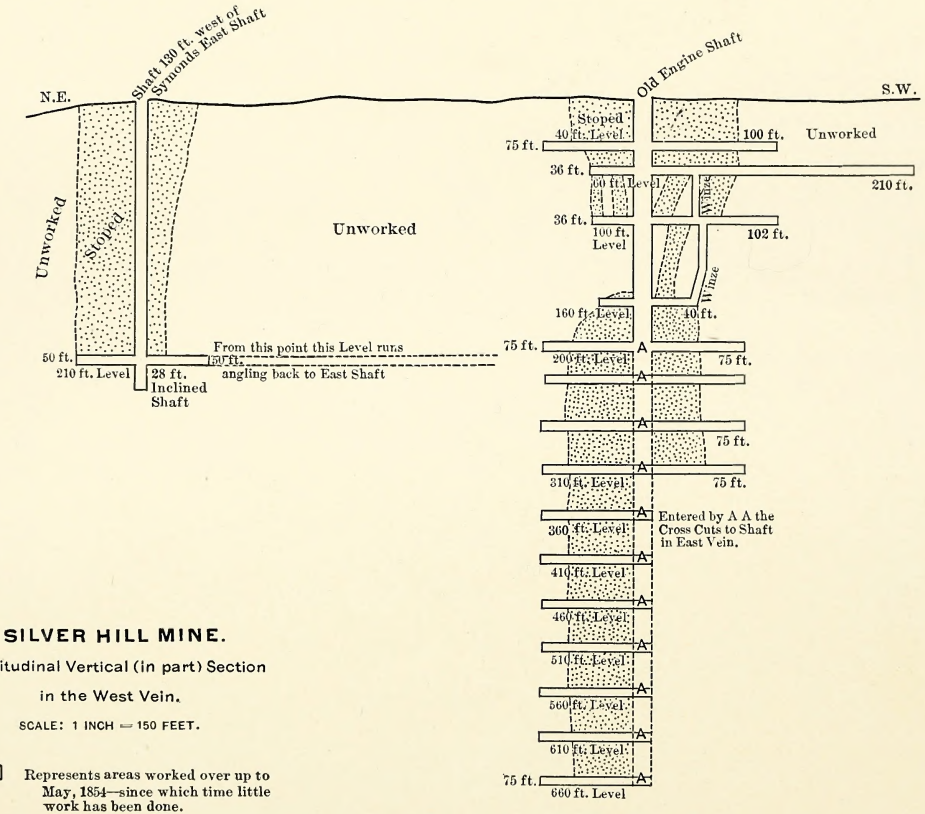
	(24)
Gold, per ton	$10.33
Silver, per ton	12.28
	$22.61



SILVER HILL MINE, DAVIDSON COUNTY.

Stippled spaces and the ground plans showing the area worked out up to May, 1854. Scale: 1 inch = 150 feet.

ENG'D BY AMERICAN BANK NOTE CO., N.Y.



SILVER HILL MINE.

Longitudinal Vertical (in part) Section

in the West Vein.

SCALE: 1 INCH = 150 FEET.

Represents areas worked over up to May, 1854—since which time little work has been done.

ENG'D BY AMERICAN BANK NOTE CO., N.Y.

The East vein above the 60 foot level was the richer in silver, and the West vein in lead, hence the former was called the "Silver vein," and the latter the "Lead vein." The space between was soft ground with disseminated mineral matter.

Two small veins are found from 100 to 175 feet in depth; the Little East vein, a few feet east of the main East vein, and nearly parallel to it; and the Little West vein, some 50 feet west of the main vein, and inclining toward it. Small outlying lenticles were encountered occasionally in driving into the "country," and the main vein was occasionally divided by "horses" of slate.

The veins come together at the 60-foot level just to the southwest of the engine shaft (plate II, fig. 3), where the West vein was the richer in silver. At the 60-foot level, and down to the 100-foot level of the West vein, there also occurred a good body of manganese ore, and associated with it most of the cabinet specimens for which this mine was noted; e. g., carbonates, sulphates, and phosphates of lead, and carbonates and silicates of copper, together with foliated and other kinds of native silver; the East vein was less rich in cabinet specimens.

The West vein also expands considerably between 60 and 100 feet; but in the expanded parts it was regularly defined, and often had "vugs" with rich mine matter. In this zone the ore was changed from oxides to sulphides, with blende predominating over the galenite. Below the 160-foot level the East vein again becomes richer in silver.

At this depth the space from wall to wall of the two veins (i. e., foot wall of East vein to hanging wall of West vein) is 32 feet, and the vein becomes more vertical, i. e., 64° from the horizontal, and sometimes expands into nests, and is frequently filled with black, cellular, steel-grained, zinciferous ore, with occasional masses of rich argentiferous galenite, and native silver. Assays of this ore show:

Assays, Silver Ore, Silver Hill Mine, East Vein, Davidson County.

	(25)	(26)
Silver, per ton	$ 25.86	$ 103.44
Lead, per cent	49	52

Galenite, associated with minerals of secondary formation, is sometimes found ranging extraordinarily high in silver.

For 160 to 200 feet the vein becomes still more steep, but at the latter depth rapidly changes to approximately 45°. Near the 200 foot level the West vein is ten to sixteen feet thick, and is filled with argentiferous galenite—the last ten feet having produced more silver than any similar distance from the 160 to the 200-foot level.

The east vein is divided by a "horse", at the 160-foot level, as shown on plate II. Both the Little East and the Little West veins carry ores quite like those of the main vein at the same depth.

Below the 200 foot level the blende gradually increases, and finally predominates over the galenite.

The composition of a large pile of ore, which had accumulated with reference to smelting, was as follows;

Assay, Ore From Silver Hill, Davidson County. (27)

Lead	17.5 per cent.
Zinc	45. "
Sulphur	25. "
Iron oxide, alumina and silica	10. "

All efforts to smelt this class of ore were disastrous and wasteful.

At 170 feet the richest ore was found in a lenticle in the general mass, two feet thick. At the depth of about 200 feet a huge shoulder or swell was encountered, making the floor nearly flat for awhile. Below 200 feet the vein and its walls assumed their permanent and normal characteristics.

The inclined shaft was sunk in the East vein, and cross-cuts driven from it to the West vein, and through them the West vein was worked, levels being driven each 50 feet on the incline. Down to 310 feet the levels extended both northeast and southwest; below 310 feet, 50 to 75 feet to the north only, since the shoot of ore appeared to be pitching to the northeast. The stopes extended 25 to 50 feet from the shaft along the levels, both veins being worked alike. At the depth of about 400 feet, the exact point not being now ascertainable, the two veins uni-

ted again, and continued together for a distance of 50 feet downward.

The ore shoots appear to be diminishing in length at the deepest point thus far attained, and are about 25 feet long in the course of the vein, but the thickness is not materially changed, and they have a width of twelve feet. Those who have been long familiar with the mine, say that it is a repetition of what has often occurred, and are sanguine that it will enlarge again.

It is believed that a large body of carbonates still exists near the surface, and down to 100 or 200 feet. This body was penetrated by the late J. Howard Jones in 1878, and a large amount of ore brought to the surface. Its character is indicated by assays Nos. 28 and 29 below. The general position of Mr. Jones' inclined shaft is shown on plate II by dotted lines; an extensive cave subsequently occurred, and its exact position cannot now be determined.

It may be mentioned that bodies of iron pyrite, with a very little chalcopyrite, are sometimes encountered, and it is believed that a considerable quantity exists. Assays Nos. 30 and 31 show its composition. Nos. 32, 33 and 34 are assays of compact galenite.

No. 35, by Prof. F. A. Genth, is the average contents during his connection with the mine, being an average of some 200 assays.

Assay, Ores from Silver Hill Mine, Davidson County.

	Carbonates.		Pyrite.	
	(28)	(29)	(30)	(31)
Gold, per ton	$ 8.27	$ 2.07	$ 3.10	$10.34
Silver, " "	20 36	4.65	4.01	2.97
	$28.63	$ 6.72	$ 7.11	$13.31
Lead, per cent	3.8 per cent	31.94 per cent	0.67 per cent	———
Zinc, " "	———	27.28 per cent	2.08 per cent	———

Assays, Compact Galena, Silver Hill Mine.

	(32)	(33)	(34)
Gold, per ton	$ 4.13	$ 6.20	$ 4.13
Silver, " "	3.23	10.73	11.25
	$ 7.36	$16.93	$15.38
Lead, per cent	22.94 per cent	56.72 per cent	12.57 per cent.
Zinc, " "	7.14 per cent	———	34.29 per cent.

General Average of 200 *Assays, Silver Hill Ores.*

	(35)	
Galenite	21.9	per cent.
Bisulphide of iron	17.1	"
Sulphide of zinc	59.2	"
Silver and gold	.025	"
Copper pyrite	1.8	"
	100.025	"

Passing to the north along the East vein are the Symonds' shafts, (plate II). Sulphide ores were encountered here near the surface, and were of the same general character. Symonds' east shaft was sunk 110 feet, and the west shaft 210 feet. Very little stoping was done in these two veins. A level was driven from near the bottom of Symonds' west shaft, running angling back to the engine shaft in the East vein.

The Silver Valley Mine is situated 5 milest northeast of Silver Hill, and 12 miles E. S. E. from Lexington. The character of the ore is very much like that of the Silver Hill mine. The mine was discovered and opened in 1880, and it was last operated in the latter part of 1893, the ore being hauled to Thomasville where it was successfully treated by a smelting process, using copper ores as a flux. A 20 stamp mill stands on the property. The old mine dumps show specimens of argillaceous schist, which it is stated form the hanging wall of the vein, while the foot wall is a hard fine grained hornstone (locally called "gun flint"), which also occurs in abundance on the dump pile. The color of this hornstone varies from a light drab to dark gray, and some specimens show a sharp contact between the two, resembling flow-structure. It has all appearances of being a devitrified volcanic rhyolite, and this is substantiated by microscopic examination. An eruptive basic rock, resembling that at Silver Hill, is also found here, and from the various statements it appears to exist in the form of a dike.

The presence of galenite was suspected thirty years ago, and much prospecting work was done to find the deposit; but the work was done mostly in the schists some distance off to the west of the present shaft, where the galenite disseminated in the schists seemed most promising. The vein now under discussion was discovered subsequently by a shrewd guess. Its strike is

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approximately north and south, with a dip of 45° to the northwest.

The quartz outcrop of the vein is nearly twenty feet wide, and is not the least promising for a mineral formation. The vein is five to twelve feet wide, and presents a laminated structure, with alternate bands of ore, slate and quartz; these ore seams are from three to eighteen inches thick. It is believed that the ore is less scattered and more solid as depth is gained.

The mine is entered by two shafts, one vertical and one underlay in the vein of 170 feet (equivalent to about 120 feet vertical), and levels have been run 100 feet in either direction from the foot of the inclined shaft, which are mostly in ore.

The contents of the vein is a milk-white and barren looking quartz, which disclosed little mineral matter until a depth of sixty feet was reached, though the upper part contained some brown ore.

The ore is very like that of Silver Hill in its lower levels, and blende has come to form a large, and in some cases, the predominant constituent. The subjoined assays will show the composition of the massive galenites and blendes.

Assays, Ore from Silver Valley Mine, Davidson County.

	Galenites and Blendes.		
	(36)	(37)	(38)
Gold per ton	$ trace	$ 4.13	$ trace.
Silver " "	17.19	176.49	38.14
	$ 17.19	$ 180.62	$ 38.14
Lead, per cent	15.54%	55.25%	38.8%
Zinc " "	31.43%	11.24%	32.0%

	Poor Concentrates.	Good Concentrates.	Second Concentrates from Poor Ore.	Second Concentrates from Solid Ore.
	(39)	(40)	(41)	(42)
Gold per ton	$ 4.13	$ 4.13	$ 1.03	$ 1.65
Silver " "	23.01	44.74	13.08	14.34
	$ 27.14	$ 48.87	$ 14.11	$ 15.99
Lead, per cent	11.18%	47.62%	9.63%	8.13
Zinc " "	27.70%	12.68%	27.84%	33.54

Assay No. 36 more nearly represents the common run of the slightly cobbed ore, and No. 38 the more massive ore; No. 37 is exceptional.

The possibility of concentrating the mine stuff into a smelting product fairly free from zinc is shown in No. 40, but the losses, as concentration has hitherto been practiced, are enormous.

The gold is far from being uniformly diffused, for the presence of a little iron pyrite makes a considerable difference in the gold contents of the concentrates.

THE WELBORN (SMITH) MINE is situated 2 miles west of the Silver Hill, and carries similar complex ores. The mine was never developed sufficiently to indicate its true resources.

The Smith or No. 1 Shaft was sunk in 1882–3 to the depth, as reported, of fifty (50) feet; at ten (10) feet in depth the vein was twelve (12) inches thick, and at thirty-five (35) it was stated to be forty (40) inches thick. The following assays give some idea of the general run of the ores:

Assays, Gold Ores, Welborn Mine, Davidson County.

	(43)	(44)	(45)
Gold, per ton, coining rate	$15.51	$10.33	$5.68
Silver, per ton, coining rate	14.37	4.20	2.26
Total	$29.88	$14.53	$7.94

Sample No. 43, Schist, with iron pyrite and a little copper pyrite and considerable galenite.
Samples 44 and 45, Schist, with disseminated iron pyrite.

Several hundred tons of ore had been accumulated on the dump in 1883, and an effort was made to smelt it, which, as a matter of course, ended in failure, as the ore contained blende.

At the Miller Shaft, three-fourths of a mile north, there were also several hundred tons of ore on the dump; the vein carried compact sulphurets with a trace of copper, and was reported to be $2\frac{1}{2}$ to 3 feet wide.

Other localities have been worked in this vicinity, e. g., the Symonds vein, but the Survey has no authentic deta respecting them.

THE CONRAD HILL MINE[1] is situated 6 miles east of Lexington, the county seat, on the northwest margin of the Carolina Slate Belt, and near its contact with the granitic rocks. The elevation of the hill is less than 100 feet above the adjacent valleys, and with very gradual slopes. The country rocks are fine grained argillaceous schists, often silicified, thinly laminated and much jointed. The strike is N. 10° to 20° E., and the dip towards the northwest at high angles, approaching the vertical.

[1]The description here given of this mine is reprinted with slight alteration from a special report made by Prof. Kerr in May, 1881, which report was published in the Baltimore *Sun* of June 4, 1881. The mine has not been in operation for a number of years past.

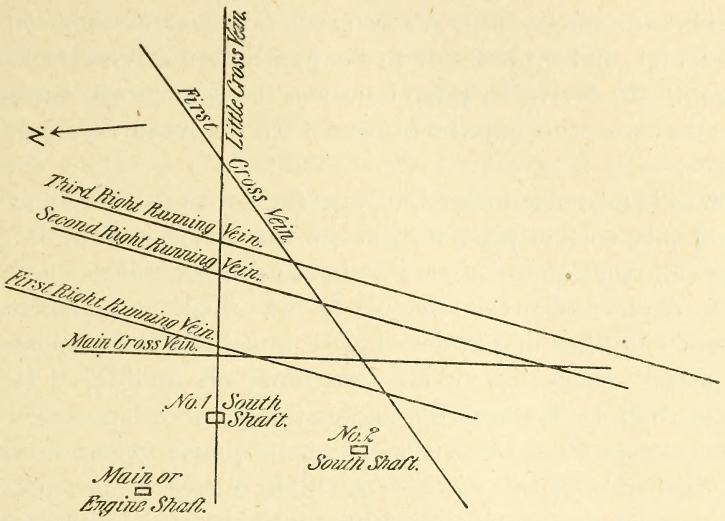


Fig 3.—Plan of veins at Conrad Hill gold mine, Davidson county. *Scale:* about 1 inch to 300 feet. (Largely after Emmons.)

There are two systems of veins traversing the hill (see fig. 3.); one consists of veins parallel to each other and to the strike of the schists, while in dip they frequently, perhaps it may be said generally, cut the schistosity, at a slightly more westerly angle. The second system differs from the first in being entirely independent of each other and of the country rock, in strike and dip.

The former, Prof. Emmons has designated[1] as *right running veins*, and the latter as *cross veins*. The gangue of both is quartz and carbonate of iron. They yield both copper and gold, the former occurring as a sulphuret (chalcopyrite), except in the upper levels, where it has suffered partial oxidation; the latter occurring as free gold, both in the quartz and in the altered carbonate (brown oxides) of iron of the upper—and in the sulphurets of the lower levels.

Emmons describes four right running veins, which he calls "*first*," "*second*" and "*third*," or "*front*," "*middle*" and "*back*" *veins*, the fourth being considered a branch of the third. The first of these crosses near the top of the hill, striking N. 10° E,, and dipping west at a high angle. The outcrop of the

[1] Geological Report of the Midland counties of N. C., 1856, pp. 143 154.

second or middle vein he places at the distance of fifty feet east of the first, and supposes it to be parallel in dip, as well as in strike, to the first. In this, however, he is evidently mistaken, since the two veins appear to meet within a hundred feet of the surface.

There is evidence in the old workings that still another vein, with a very steep dip, exists between the second and third. This back vein we suppose to cross the line of the South shaft at a depth of less than 130 feet. In its thickness, and in the amount and kind of matter which composes it, he considers this the most remarkable of all the veins of the hill. "It is 15 inches thick at its outcrop, and at the depth of between 60 and 70 feet it is 10 to 18 feet wide. It is quartz above, but at 50 feet carbonate of iron, carrying sulphurets of copper and iron, this part of the vein being four feet thick at the 90-foot level, and rich in gold."

Emmons mentions also 3 cross veins, one as having no outcrop, and only revealed in the engine shaft, and two others which he describes as among the richest of the whole hill. The first of these latter was worked to a depth of 90 feet, and seems to be the one represented as crossing the South shaft, No. 1. The other, having a strike nearly east and west, and a dip south, was worked to a depth of 60 feet, and showed a width of 4 feet of very rich ore, on which a drift of some 60 feet was run. It must, therefore, be the vein which appears on this cross course in South shaft No. 2.

In addition to these there appear to be two other veins, not discovered when Emmons wrote his description—not showing themselves, apparently, on the part of the hill to which his attention was confined. One of these is a very large vein—larger than any of those above described.

The veinstone is quartz and iron carbonate, carrying copper pyrite and gold. This vein is exposed in all three of the shafts, below the point where the other veins are cut—below 100 feet. It is not clear where this vein comes to the surface, or whether it is put down on the sketch as the *main cross vein*. The other new vein is indicated on the diagram to the west of, and parallel to

the first or front vein. It has been opened by several shallow pits, and shows a four-foot quartz vein, with visible gold. An unsorted sample of the excavated mass yielded, in an assay by the company's chemist, $31 per ton for gold.

There are three shafts sunk on the property, as shown in the diagram, and as they are all in front of the right running veins, these will all be penetrated by each of them at the same depth. In No. 1 South shaft, Emmons estimated that the last of them, the back vein, would be cut at 130 feet. A large body of ore was entered at the depth of 98 feet, where, according to Captain Edward B. Wilder, the front and middle veins have united and form one mass. From this shaft, at the depth of 105 feet, a drift was run some 40 feet north and 90 feet south, along and in this body of ore, exposing a thickness of 5 to 10 feet, all of which "contained gold in paying quantities."

The veinstone is quartz, iron carbonate and spongy brown oxide of iron, carrying free gold and copper sulphurets and carbonate. In the lowest part of this great mass of ore, the richer portion, about 4 feet wide, separated from the remainder of the vein by a well-defined line of demarkation, will all assay high —up to $300 per ton.

* * * * * * * * * * * *

Just south of the shaft, a cut has been made from the drift, across this body of ore, measuring some 37 feet, to the foot wall, giving a thickness of upwards of 20 feet. A large part of this thickness is composed of crushed slates filled with strings of quartz. A sample taken across this section, which is 10 to 15 feet high, including slates, quartz and everything representing the whole body of the vein, yielded $22.73 per ton (Hanna). Of course by a process of selection, throwing out the poorer masses of quartz, spar and slate, the yield per ton might be doubled or increased even to a higher percentage.

Just north of the No. 1 South shaft, in the same level, is cut Emmons' second cross vein, which seems to coalesce with the bed of ore just mentioned. There is, therefore, exposed an immense mass of ore, in the mere exploitation of which, by the drifts and

cross-cuts, made in the development of this part of the vein, a pile of material has been accumulated at the surface, which is estimated to contain nearly 3,000 tons of ore, of which an average sample gave Mr. Clausen, chemist of the Conrad Hill Gold and Copper Company, $28.60 per ton.

In No. 2 South shaft, according to Wilder, the veins cut at 67 feet represent the front and middle veins of Emmons. On this point "a cross-cut has been driven 62½ feet back and into the first and second veins, and two levels started, one each way, on the course of the first vein. Both sides of the drift are in good ore, and in the southeast side a course of gold and copper ores, varying from 18 to 24 inches in thickness, has been exposed. Indications are that the ores here are as rich and abundant as at No. 1 South shaft." At the depth of 100 feet a drift has been carried some fifty feet south in a mass of ore, of which only the foot wall is exposed, on which lies an ore course of about 2 feet, the veinstone being quartz and brown oxide of iron, carrying gold and copper. A sample taken along this ore body gives (Hanna) $13.39 gold per ton.

Some forty feet north of this shaft, on the same level, a similar ore course of 12 to 20 inches of prill copper (i. e. 33 per cent. copper) is exposed towards the upper part of the vein, while a stope driven up and along the middle of it, in brown oxide and iron carbonate, gives, by assay of sample representing a thickness of 3 feet, $17.58 for gold (Hanna). This is probably Emmons' second vein. There is exposed in these two drifts a face of nearly 100 feet of ore, with three good ore courses, within a total exposed thickness of the vein of not less than ten feet the hanging wall being nowhere in sight.

Forty or fifty feet more of drifting will connect this level with that coming south from No. 1 South shaft. Emmons' third cross vein is cut in this shaft at the depth of 57 feet, but no new excavations have been made at this level. "At a vertical depth of 103 feet from the surfice this shaft cuts into, and at 122 feet passes through, the main cross vein, proving it to be 17 feet thick at this point, and composed of quartz and carbonate of iron, with more or less yellow sulphuret of copper. The vein is underlying

at 46°, and the shaft will be continued down the incline of the vein, which has been more thoroughly exposed in the main shaft." This shaft, therfore, opens four important veins, and it is within 40 feet of the new vein, which was recently discovered, and which can also be worked from this direction. The quantity of ore accessible from this point, therefore, and within a very moderate depth; is immense, and this takes no account of the back vein, which, of course. must be reached at no great depth below the present termination.

The Main or Engine shaft is situated 195 feet west of No. 1, and is distant 240 feet from No. 2 South shaft. It was sunk 220 feet vertically, and subsequently to 400 feet. At 163 feet the shaft passes through the main cross vein. Throughout the entire distance a rich course of copper ore is exposed from 3 to 8 feet in thickness, of which 1 to 4½ feet is solid prill ore, giving an average of not less than 2 feet. Samples taken from across the whole distance of the face of this prill, and assayed by Hanna, give $11.98 gold per ton in addition to its copper value. This ore course of prill copper was also exposed, in a thickness of not less than 5 feet, in a drift northwards, at the 175 foot level.

The general course of metallurgical treatment at this time was as follows: The matter was partly sorted out underground, and still further hand-cobbed and picked in the sheds; the richer ore was sent at once to the copper works; the residues, after passing through a Blake Crusher, were jigged, and the best material added to the richer mine stuff above alluded to; the poorest material from the jigs was rejected, the medium grade sent at once to the stamp battery and amalgamated as usual; the tailings from the battery were partly concentrated by buddles and blankets, and the concentrates sent to the copper works.

At the outset, the richer copper minerals were, after roasting, smelted in a shaft furnace for matte, from which, after re-smelting, black copper was obtained and refined. The material, however, was not suited to this treatment, as the necessary basic matter was lacking to make a proper flux, and smelting was superseded by the wet method under the Hunt & Douglas patent (old method), i. e., the crushed ore after roasting was subjected to

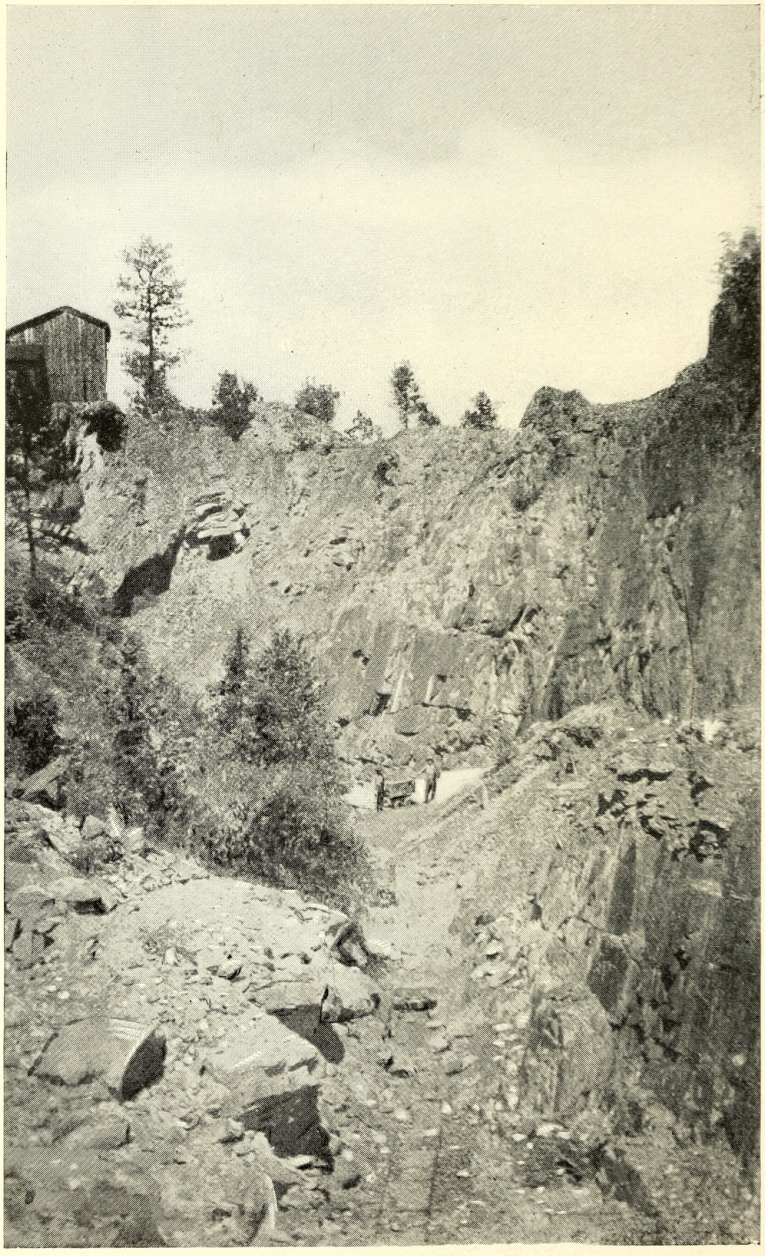
a bath of protochloride of iron, for the conversion of the insoluble copper mineral into the soluble chloride; after leaching the copper was precipitated by metallic iron and refined. The residues, now mostly peroxides, were sent back to be milled and amalgamated, and, to a slight extent, concentrated again. The final products were gold bullion and refined ingot copper.

MONTGOMERY COUNTY.

The deep mines of this county have been very prominent in the mining history of the State. The most important group is situated in the extreme northwestern corner of the county, in the vicinity of the village of Eldorado.

The Russell Mine is situated about 3 miles north of Eldorado, near the Randolph county line. It has been worked more extensively than any other, and has therefore allowed better opportunity for study.

The county rock is an argillaceous slate, both of the soft and silicified types; it also contains small quartz stringers. Some specimens of the silicified slate showed coatings of calcite, and specimens of the softer slates contained small irregular calcite veins; presumably the slate in general is somewhat calcareous. The strike and dip are variable. In the eastern end ef the "Big Cut" the strike of the schistosity is N. 55° W., dip 40° N. E. In a tunnel leading from the cut southward to the open air, the bedding planes of the slates are nearly horizontal, with gentle undulations. In another tunnel entering the hillside, west of the "Big Cut," the strike of the schistosity is N. 24° E., and the dip 56° to 80° N. W. The grain of the slate was determined here; its strike is N. 45° E., and the dip 35° S. W., showing that the cleavage was produced by a force acting from the Southwest downward, and developing normal faulting. The compression was not great. The bedding and cleavage planes usually coincide, but in cases, particularly where the bedding is at a small angle to the horizontal, they do not coincide, the cleavage being much steeper. The cleavage planes are also marked by groovings. Pyrite (with the merest traces of chalcopyrite) to the extent of from 2 to 4 per cent. is almost universally present in



BIG CUT, RUSSELL MINE, GLEN BROOK, N. C.

the slates. It is disseminated in isolated crystals up to ⅛ cube, and also in irregular stringers, lenticles and coatings. The entire formation is gold bearing, but only certain belts are rich enough to warrant mining operations.

To one unfamiliar with the formation, it is difficult to distinguish any difference between the richer and the poorer portions except possibly in the fact that the former are somewhat more altered; and even the miner, long familiar with the region, is often at fault, and ascertains his true course only by constant "panning."

Occasionally the working body jumps abruptly, in one case not less than ten feet, and sometimes further on resumes its old course. The change in grade is even more perplexing, for the external signs of rich and poor ore are of the vaguest kind.

There are at least 6 of these belts within a distance of 2,000 feet across the strike, known as the "Little Lead," the "Big Cut," the "Riggins Hill Lead," the "Soliague Lead," the "Walker Lead," and the "Laurel Hill Lead."

Of these the largest and most extensively worked is the "Big Cut," which is an open cut, about 300 feet long, by 150 feet wide, by 60 feet deep. (See plate IV.)

The ore was mined by blasting down large masses at a time, and the cost of mining was thus reduced to a minimum. On the eastern edge of the cut is a shaft 150 feet deep, from the bottom of which the ore has been stoped upward.

It is stated that the average ore, embracing the entire material from this cut, milled $2.00 per ton. There were some streaks from 4 to 5 feet wide, which went much higher, and portions of the ore were so rich that it was carried out in powder kegs.

The following series of assays shows how wide the variation is:

Assays, Gold Ores, Russell Mine, Montgomery County.

	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)	(56)
Gold (per ton)	$2.07	$2.07	$3.10	$3.10	$4.13	$5.17	$7.24	$9.30	$9.30	$10.34	$14.47
Silver " "	.06	.26	trace	.22	.10	1.10	.61	.39	.84	1.06	1.55
	$2.13	$2.33	$3.10	$3.32	$4.23	$6.27	$7.85	$9 69	$10.14	$11.40	$16.02

Assays, Gold Ores, Russell Mine (Continued).

	(57)	(58)	(59)	(60)	(61)	(62)	(63)
Gold (per ton)	$22.74	$39.27	$43 40	$84.75	$173.63	$237 70	$320.38
Silver " "	.13	.77	4.29	2.07	3.10	6.31	12.08
	$22.87	$40.04	$47.69	$86.82	$176.73	$244.01	$332.46

A forty stamp mill in good condition is located on the property. The mine was not in operation when last visited in the late fall of 1894; but preparations are now in progress for the erection of a cyanide plant for the treatment of the ores.

The Appalachian (or Coggins) Mine is situated in close proximity to Eldorado. The schists here have a strike N. 40° E., and dip steeply to the northwest; they are quite similar to those of the Russell, though possibly less siliceous or more chloritic.

The mine, as far as developed, shows large bodies of low-grade ore similar to those of the Russell, yet ores that are easily within the limits of profitable work.

At the surface there appeared to be two ore bodies separated by a narrow and comparatively barren bed of schists of like character.

The depth of the last workings was 160 feet. A forty stamp mill stands on the property.

Several assays of the ore show its variation, similar to that of the Russell.

Assays, Gold Ores, Appalachian Mine, Montgomery Co.

	(64)	(65)	(66)
Gold (per ton)	$2.07	$4.65	$113.68
Silver " "	.13	.16	1.29
	$2.20	$4.81	$114.97

The Morris Mountain (Davis or Dutton) Mine is one mile nearly west of the Appalachian. The occurrence of the gold is similar to that at the Russell mine. It is occasionally concentrated in the joint planes of the slates, which are sometimes very rich. On account of the small developments, the capabilities of

this mine have never been demonstrated. Assays of the ores have shown the following contents :

Assays, Gold Ores, Morris Mountain Mine, Montgomery County.

	(67)	(68)
Gold, per ton	$3 61	$82.68
Silver, per ton	.68	trace
	$4.29	$82.68

The Riggon Hill Mine is situated 3 miles east of Eldorado. The ore body consists of a quartz vein, reported to be 2½ feet in thickness, lying approximately conformable with the schistosity of the country rock. It has been opened by a prospecting shaft, 100 feet in depth. Rich ores, both in gold and silver, are reported from here.

The Steel Mine, and its extension, the Saunders, are on the east side of the Uharrie river, 2 miles southeast of Eldorado. The nature of the country rock and of the ore deposits are quite like those of the Russell mine.

The ore body varies from 9 to 12 feet in thickness, and occasionally rises to 20 feet. The strike is N. 25° E., and the dip 70° N. W., becoming steeper as depth is gained.

The most valuable part of this deposit consists in what is locally called "string veins"—narrow seams of ore, which run through the mass with some general conformity to the slates. There are usually several of these strings approximately parallel, and from a line to nearly twelve inches in thickness. The combined thickness of these seams is rarely less than 15 inches, and is sometimes more than three feet. There is a considerable proportion of free gold present, but a large part is so intimately associated with the sulphurets as to be refractory to any mere mill process, and will need a smelting treatment. The associated mineral matter is galena, blende, chalcopyrite, and pyrite.

The rich ores of this part of the ore body have, ever since the mine was worked, been called "No. 1" ores, and are so alluded to in all reports. The rest of the deposit has a very small but varying proportion of sulphurets, and is generally rich enough to

justify the treatment of the entire mass. This ore is known as "No. 2".

The remarkable richness of some of these "No. 1" ores is shown by the following assays by Prof. F. A. Genth:

Assays, "No. 1" Gold Ores, Steel Mine, Montgomery County.

	(69)	(70)	(71)	(72)
Gold, per ton	$428.90	$564.70	$2,648.24	$9,665.70
Silver, " "	not det.	10.03	51.07	151.54
	$428.90	$574.73	$2,699.31	$9,817.24

Assays of "No. 2" ore, also by Prof. Genth, have shown the following results:

Assays, "No. 2" Gold Ores, Steel Mine, Montgomery County.

	(73)	(74)	(75)	(76)
Gold, per ton	$26.46	$39.27	$55.19	$161.84
Silver, " "	2.53	2.45	2.08	4.60
	$28.99	$41.72	$57.27	$166.44

An examination of these figures will justify the early reputation of the mine for richness. As a matter of course the most ardent friends of the mine do not claim any such values for the ores at the present depth (220 feet). The mine was last operated by the Genesee Gold Mining Company in connection with a 40 stamp mill. The sulphurets were concentrated for metallurgical treatment.

The Beaver Dam Mine is situated at Flaggtown postoffice, 2 miles northeast of the junction of Beaver Dam creek and the Yadkin river. The mining tract contains 800 acres, one-half of which is claimed to be underlaid by gravel. This gravel is from 2 to 4 feet thick and overlaid by an alluvial deposit 5 to 15 feet thick. The bed rock is a decomposed silicified schist.

A fair supply of water is afforded by Beaver Dam creek for hydraulic operations. The fall from the gravel bed to the river, along Beaver Dam creek, is one inch per rod, for a distance of 1½ to 2 miles. Operations on a large scale have always been hindered by the presence of a tenacious white clay, which is commonly mixed with the gravel. Much of the broken down quartz would apparently bear a mill treatment, if an automatic

and cheap process could be introduced as an adjunct to hydraulic mining.

There are large and extensive bodies of greenstone on the property, which contain a sprinkling of iron pyrites, and gener ally a little gold, as follows:

Assay, Pyritiferous Greenstone, Near Beaver Dam Mine.

	(77)
Gold, per ton	$2.07
Silver, " "	.32
	$2.39

This is mentioned to show the extent and character of the diffusion of gold.

The Moratock Mine is situated 6 miles north of the Sam Christian, and 8 miles south of Eldorado. The country rock is a highly silicified quartz porphyry and a brecciated tuff. The quartz porphyry at first sight resembles a compact, homogeneous hornstone or flint, but upon close examination it is found to contain small, black, glassy specks, which are presumably quartz. However, the true porphyritic nature of the rock is clearly brought out in the weathered specimens, the feldspathic ground-mass being decomposed and altered, while the quartz remains intact as crystals with partially rounded, but yet distinct hexagonal outlines. Indistinct flow structure is also visible in the fresh rock, and it is emphasized in the ground-mass of the altered specimens. The porphyry contains pyrite crystals up to $\frac{1}{8}$ inch cube, sparingly distributed: (1) irregularly, (2) along small seams, and (3) in minute cavities or geodes. Some chalcopyrite also occurs. The main rock mass is intersected by several small quartz fissure veins, less than one inch in thickness, and these are reported to be rich in gold. The brecciated tuff was not seen in place, but several very large boulders were found in the hill-side near the mill. Some of the porphyry fragments in this breccia are as large as 12 inches square. Chalcopyrite and green copper carbonate stains were also noticed.

The Moratock mine was first opened about 2 years ago, and the principal work consists of a small open quarry in the pyritic quartz-porphyry mass. However, the percentage of sulphurets

in this rock is so insignificant that it could never make a workable ore. It is stated that the assays showed less than $1.00 per ton. A shallow shaft has also been sunk in one of the narrow quartz veins. Altogether, it appears only natural that the whole undertaking should be abandoned, as it is. A ten stamp mill, equipped with a cyanide plant, stands on the property.

The Reynolds Mine, 6 miles northeast of Troy, and the *Carter*, a little nearer to Troy, have been worked to the depths of 80 and 100 feet respectively. Little is known of these mines. Both of them contain telluride of gold, according to Emmons.[1]

A belt of gravel mines is found on the west flanks of the Uharie mountains, and between them and the Uharie river. The northernmost limit of these deposits is known to extend to Barnes' Creek in Randolph county, and may even reach to within 5 or 6 miles of Asheboro.

The localities best known and most worked are the Bright, Ophir (or Davis), Spanish Oak Gap, Dry Hollow, Island Creek, Deep Flat, Pear Tree Hill, Tom's Creek, Harbin's, Bunnell Mountain, Dutchman's Creek, and the Worth, the latter being near the junction of the Uharie and the Yadkin.

All of these were largely and profitably worked as long as the naturally concentrated material lasted, and the proximity of water favored work. At present the supply of available water is entirely inadequate for the working of these properties, and the tailing ground is not always favorable. The presence of a tenacious clay with the gravel has also caused difficulties in the treatment. Occasionally a brilliant find of nuggets is made which gives a spasmodic, but short lived, activity to the section, but no large work or permanent activity can be expected, till an abundant and sure supply of water can be secured.

The Sam Christian Mine is situated 12 miles east of Albemarle, and 3 miles east of Swift Island Ford.

This mine has gained something more than a local reputation, and has been productive of remarkably large and fine nuggets.

The gold is found in old "channels", in gravel of a thickness from one (1) to three (3) feet, and deeply covered with soil. It

[1]Geology of the Midland Counties of North Carolina, 1856, pp. 168—169.

is rarely found in the shape of dust, but generally in nuggets of from 5 to more than 1,000 pennyweights.

The tract contains 1,286 acres, and has been worked in several places, especially "Dry Hollow," "The Sam Christian Cut," and "California Cut." Other channels are also known.

The method of work pursued at this mine consisted of a removal of the soil resting on the gravel, followed by a very careful washing of the gravel in sluices and rockers. Where the overlay was slight it was removed by simple digging. In other cases it was washed away by hydraulic giants. The "harvest" periods were uncertain and intermittent; a few days or even a few hours would sometimes suffice for obtaining a large reward for weeks or months of almost unproductive labor. The following interesting table of 40 nuggets, obtained from 1,070 cubic feet of grit in 1880, illustrates well the result from a campaign of 88 washing days:

Weights of 40 *Nuggets, Sam Christian Mine, Montgomery County.*

Dwts.	Dwts.	Dwts.	Dwts.
430	22	15	41
59	32	11	148
39	22	66	540
167	132 (2 nuggets)	21	240
16	141 (9 nuggets)	13	241
64	26	55	6
1,024	62	48	Total 4,200 dwts.
5	30	484	

The mine was last operated about 1893. Water was supplied from a pumping station on the Yadkin river, some $2\frac{1}{2}$ miles distant, through a line of 20-inch iron pipe. The total elevation of the point of discharge above the water level at Swift Island ferry is 416.8 feet.

The country rock at the Sam Christian is the argillaceous slate of the Monroe type (see p. 36), of which there are some "good exposures" in the "Dry Hollow." A number of strikes were observed here, from N. 5° W. to N. 20° E., with dips from 45° S.W. to 30° N.W., and in places nearly horizontal. The slates show distinct banding, with and at angles to the cleavage. These slates are broken through by large eruptive masses of devitrified volcanic breccia and hornstone, the true field relations of which, however,

could not be satisfactorily determined, but the coarse breccia contains fragments of the hornstone (as large as 4 inches square), and is most probably a tuff agglomerate. The hornstone contains occasional fine particles of pyrite. Its surface weathers with a raised layer of rounded concretions, thus resembling the quartz porphyry at the Moratock mine (see p. 79). Very good exposures of this rock were seen in the "Sam Christian Cut." This eruptive rock contains small quartz fissure veins from ½ to 3 inches wide, striking N. 70° W., and dipping 60° N. E.

Several shafts have been sunk in some of these narrow veins, and it is almost needless to remark that attempts at deep mining on ½ to 3-inch veins were failures. The gold in the gravel came from the breaking down of the numerous small quartz veins in the underlying and contiguous rock. Seven such veins, all less than three inches thick, are shown on plate V, as they are exposed in the upper end of the "Dry Hollow" gulch of the Sam Christian mine.

MINES IN STANLY COUNTY.

The Haithcock, Hearne, and Lowder mines are from 2 to 4 miles northwest of Albemarle, the county seat. The quartz veins of these mines are stated to be from 2 to 4 feet in thickness, lying approximately conformable with the schists. No active work has been carried on for a great many years. Some prospect work was in progress at the Lowder mine during the summer, 1895.

The Crawford (or Ingram) Mine is situated 4 miles northeast of Albemarle. It is a placer deposit of comparatively recent discovery (August, 1892).

The auriferous gravel is situated in the valley of a small stream, and is overlaid by 2 to 4 feet of soil. The thickness of the gravel is from 1½ to 2 feet in the centre of the basin, thining out towards the edges. The width of the deposit is about 250 feet.

The bed rock is slate of the Monroe type, lying in a flat synclinal. The gravel is composed of angular fragments of this slate and white quartz, bound together in a clay matrix. The lack of sufficient water for washing the material on a large and continu-



SMALL QUARTZ VEINS IN DECAYED SCHISTS, AND OVERLYING AURIFEROUS "GRAVEL."—SAM CHRISTIAN MINE.

ous scale presented a serious difficulty at this mine. In 1894 the Crawford Gold Mining Company solved this problem by a very unique device. A wooden tank, holding about 200 cubic yards, is situated at some elevation above the stream bed. At one end of the tank is a stand pipe, about 30 feet high, which is supplied with water from a reservoir below by a steam pump. The gravel, together with a portion of the overlay and bed rock, is hauled to the top of the tank in tram cars, and dumped. Here it is washed by the discharge from the stand-pipe. A line of riffled sluice boxes runs from an opening in one side and near the bottom of the tank. The gold is collected from the bottom of the tank and from the riffles in the sluices. It occurs exclusively in the shape of nuggets, there being no dust gold to speak of.

Two particularly large nuggets have recently been found here, one weighing 8 pounds and 5 ounces, on April 8, 1895, and another weighing 10 pounds, on August 22, 1895.

Some of the gravel is worked directly in rockers, by tributers, who pay a royalty for this privilege.

The source of this nugget gold has not yet been found. On the hillside, adjoining the shallow valley in which the gravel deposit is situated, several quartz veins, from 2 to 3 feet in thickness, have been explored. Pan tests show that the quartz is very slightly auriferous in places, but there is no sign of coarse gold.

The Parker Mine is situated at New London, about 9 miles northwest of Albemarle.

The country slates are those of the Monroe type; they are intruded by successive flows of greenstone porphyry and some more basic eruptives, in part brecciated. The mine shafts have disclosed at least two such eruptive sheets, from 2 to 3 feet each in thickness, lying nearly horizontally and separated by sedimentary slates. In places the greenstone is sheared into nearly vertical schistose masses.

Numberless auriferous quartz stringer veins, from less than one to eighteen inches in thickness, intersect the country rock in all directions. Besides these several larger and more persistent veins occur. The quartz is imperfectly crystallized and often cellular. Weathering agencies have distributed the gold through the

decomposed rock (soil) to depths of 10 or 20 feet. A combination sluicing and milling process (Dahlonega method) was in operation here at one time; the results, however, were unsatisfactory. The flushed material milled only about 50 cents per ton, although the quartz itself is shown by some assays to run as high as $4 to $6 per ton. It was, however, impracticable to select it.

The principal yield of gold at the Parker mine has been from the old gravel channels. The gold was coarse, and in nuggets. The largest nugget of which there is accurate knowledge weighed 8 pounds, 3 oz, 2 dwts. The aggregate production is estimated at $200,000.00.

The value of the gravel is stated to vary from $0.044 to $2.44 per cubic yard. Although hydraulicking is at present abandoned, the placer ground has not been exhausted. At one point examinations have shown that the bed rock of the gravel channel is a sheet of soft decomposed greenstone but 3 feet in thickness, and that this is underlaid by still another gravel deposit, which will warrant hydraulic operations. The hydraulic plant, which is in good condition, consists of a pumping station at the Yadkin river, 4¼ miles distant, and an iron pipe line to a stand pipe, situated near the mine. The head furnished from the stand pipe to the workings is about 90 feet.

The present work at this mine consists in the development of some of the larger quartz veins. The "Ross" shaft is being sunk and it is expected to intersect an ore body by means of a cross-cut extending eastward from the 120-foot level. Some surface washing is being carried on with the water pumped from the above shaft, the general returns being 80 to 100 dwts. per month. One nugget of 3 ounces was recently found (Nov., 1895).

Some assays of the vein quartz show the following results:

Assays, Gold Ore from the Parker Mine, Stanly County.

	(78)	(79)	(80)	(81)
Gold, per ton	$ 13.43	$ 7.23	$ 4.14	$ 3.10
Silver, per ton	.32	.20	trace	trace
	$ 13.75	$ 7.43	$ 4.14	$ 3.10

No. 78. Quartz vein. Upcast shaft.
No. 79. Accompanying wall rock (schist), 5 feet thick.
No. 80. Flint Spring vein.
No. 81. Other quartz veins.

The Crowell Mine is but a short distance from the Parker. The ore body does not differ in a marked degree from the adjacent

"country," for both are auriferous. Both are silicified, sericite and chlorite schists, containing finely disseminated pyrite. The ore body is from 4 to 7 feet in thickness, and will frequently pay to work as a whole. The "pay-streak" is much narrower, and often becomes only a line in thickness. The last workings extended to a depth of 125 feet.

The range of value of the ores is indicated by the following assays:

Assays, Gold Ores from the Crowell Mine, Stanly County.

	(82)	(83)	(84)	(85)
Gold, per ton	$ 7.23	$ 10.23	$ 23.87	$168.46
Silver, per ton	.91	.17	trace	71
	$8 14	$ 10.40	$ 23.87	$169.17

The Barringer Mine is situated 4 miles southeast of Gold Hill. Enormously rich ore is occasionally found, but the mine has been so long and so largely in litigation, that no considerable exploratory work has yet been done. The ore is frequently very deceptive and assays much richer than its appearance warrants, viz:

Assays, Gold Ores from the Barringer Mine, Stanly County.

	(86)	(87)	(88)	(89)	(90)
Gold, per ton	$ 2.07	$ 5.17	$ 5.17	$ 346.23	$ 540.00
Silver, per ton	.26	.26	.32	2.26	4.52
	$ 2.33	$ 5.43	$ 5 49	$ 348 49	$ 544.52

None of these samples differed much in external appearance.

MINES IN ROWAN AND CABARRUS COUNTIES.

The Gold Hill Group of Mines.[1] This constitutes one of the most noted mining districts in North Carolina, and has been one of the most productive.

The village of Gold Hill is situated 14 miles southeast of Salisbury on a branch line of the Southern R. R.

The group comprises a number of mines situated in a belt of auriferous schists, lying directly east of the Dunn Mountain granite area, nearly 1½ miles long, from northeast to southwest, and ⅔ mile wide, from northwest to southeast, in the southeast corner of Rowan County, extending over into Cabarrus County on the south, and Stanley County on the east.

[1]Geological Report of the Midland Counties of North Carolina. E. Emmons, 1856, pp. 154, 166, 205, 207.

None of these mines are now in operation and but little can be seen.

The outcrops of the veins were not bold, and in some cases (the Randolph, for example), were so obscured and covered, that they were only discovered by accident, and at a comparatively late date in the history of mining in the State—1842.

This series of mines is situated on the narrow plateau of a low-lying northeast and southwest ridge, which is broken by a small gulch near the Standard mines, and by a still deeper gulch on the McMakin tract, making the surface here quite hilly. The ridge generally slopes gently both to the southeast and to the northwest.

The mines are grouped quite closely together, and very little mineral matter is found to the west of Buffalo creek, which skirts the ridge on the west.

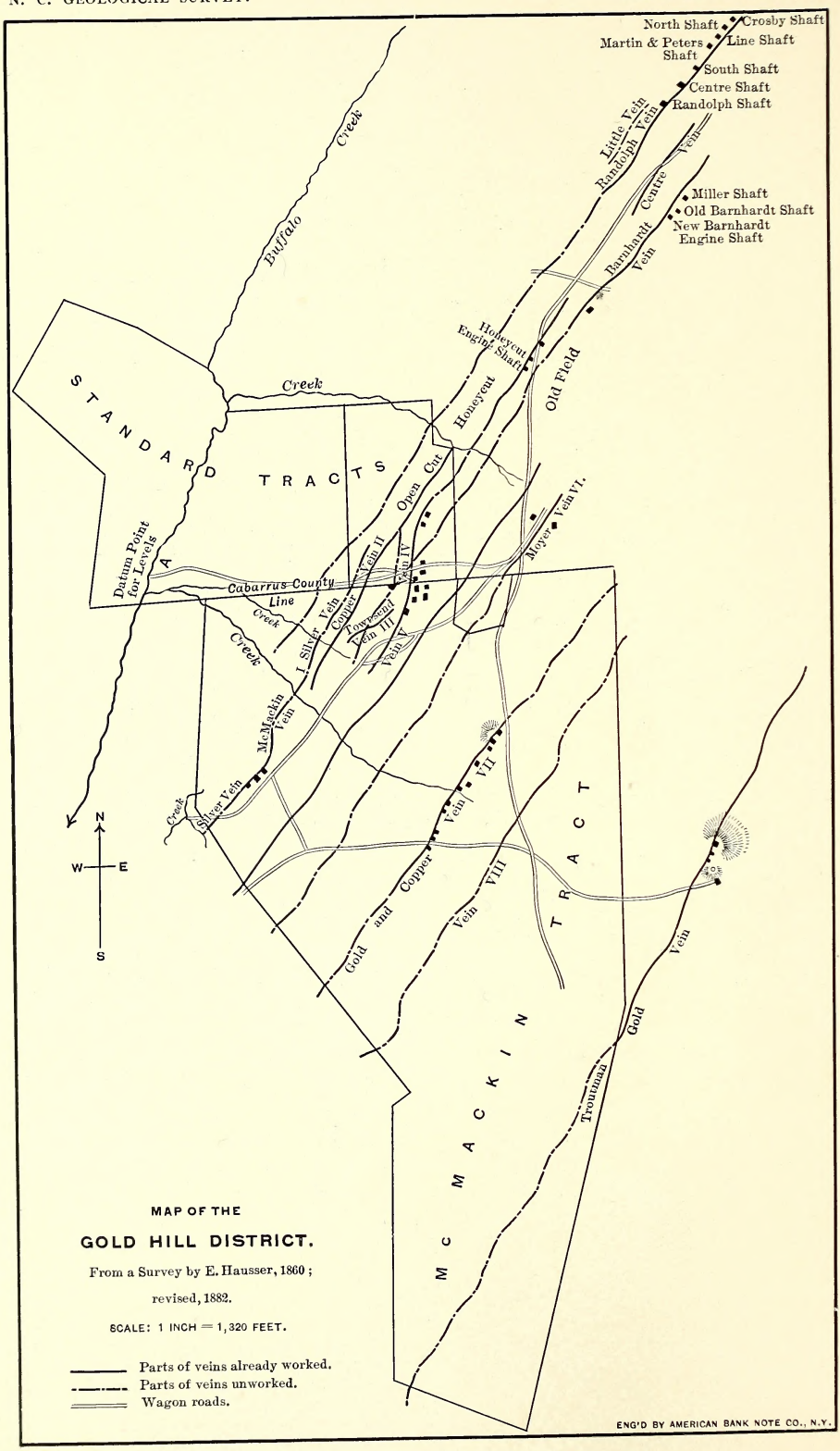
The country schists are chloritic and argillaceous, the chloritic constituent being if anything more marked at the northeastern end, and the argillaceous at the southwestern. The strike of the schistosity is N. 25° to 30° E., and the dip generally 75° to 80° N. W., occasionally vertical, and rarely slightly to the east of the vertical.

A diabase dike, about 15 feet in width, intersects the country in the Randolph and Barnhardt workings. It strikes N. 13° W., and is said to split into two prongs between the Center and Barnhardt shafts.

The character of the ore bodies is that common to the "slate belt" elsewhere. The schists are impregnated, over certain widths, with auriferous sulphurets (pyrite, chalcopyrite and galena) occurring in isolated crystals and small lenticular masses, and accompanied by lenticular stringers of quartz. And these belts constitute the so-called "veins."

The shoots or ore bodies have generally a northerly pitch of their own in the veins, i. e., the workable bodies of ore occur alternating with relatively barren schists, and these bodies tend to the north more and more as the depth increases.

There are at least 10 well-defined veins in the district (see plate VI).



MAP OF THE

GOLD HILL DISTRICT.

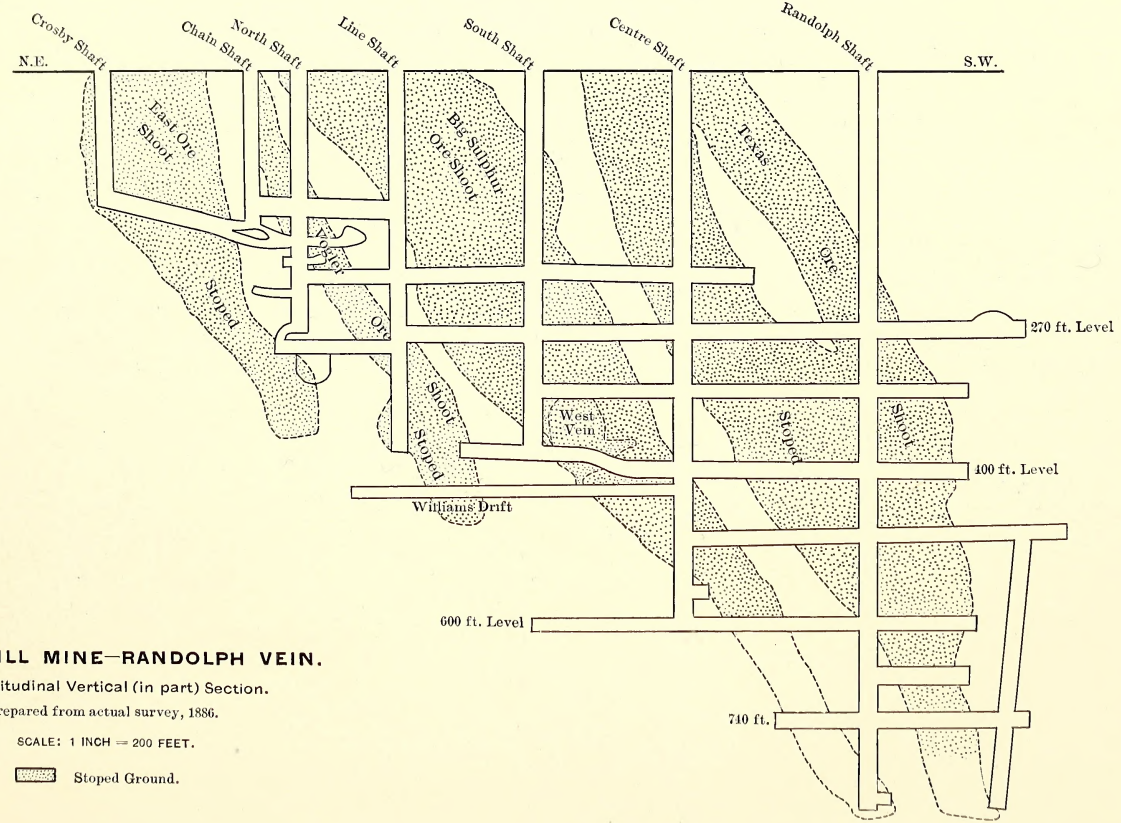
From a Survey by E. Hausser, 1860;

revised, 1882.

SCALE: 1 INCH = 1,320 FEET.

Parts of veins already worked.
Parts of veins unworked.
Wagon roads.

ENG'D BY AMERICAN BANK NOTE CO., N.Y.



GOLD HILL MINE—RANDOLPH VEIN.

A Longitudinal Vertical (in part) Section.

Prepared from actual survey, 1886.

SCALE: 1 INCH = 200 FEET.

Stoped Ground.

ENG'D BY AMERICAN BANK NOTE CO., N.Y.

Prominent among these are the Randolph, Barnhardt, Hunnicut (Honeycut), Open Cut copper vein on the Standard property, the Trautman gold vein and the McMakin silver vein.

But closely associated with these are outlying bodies, which may also be independent veins—for example, the Old Field body, which is between the Barnhardt and Hunnicut veins, and is made up of several nearly parallel bodies of ore which are very narrow, varying in width from one to several inches, intercalated with the schists and very tortuous.

The Hunnicut vein has been proved for a length of 400 yards, and the Barnhardt for an equally great distance. Most of these veins conform to the schists both in strike and dip.

The *Randolph* (or Earnhardt) *vein* occupies a position on the extreme northwestern edge of the group. It has been worked for a linear distance of 1500 feet, and to a depth of 740 feet. (See Plate VII.) It is this vein, discovered in 1854, which has contributed most to the celebrity of the Gold Hill district, and is in reality *The Gold Hill Mine.* The ore chimneys or shoots are especially marked; they are three in number and extend to the lowest depths to which the mine has been worked.

The Randolph shaft passes through the Texas shoot, just cuts the northern edge of the Big Sulphur shoot, and is but a few feet distant from the Randolph shoot. The ores below the water level are highly sulphuretted, being mostly iron pyrites. The lowest level, at 740 feet, carries considerable bodies of auriferous pyrites, containing (according to Mr. Hambly, a former assayer to the company), about 2 per cent. of metallic copper.

The thickness of the ore body is stated by Emmons (in 1856, when the depth of the mine was 410 feet) to be from 6 inches to 4 feet, and in one part 7 feet.

As respects the value of the ores it is very difficult to speak with exactness, for most examinations and reports have been made with reference to the plans of speculative promotors of mines. Some statements that have been made public are unquestionably too high to be expected from steady work. It is probable that the contents will be of low grade, as compared with the ores nearer the surface.

Some indication of the range of values is given in the following assays:

Assays, Auriferous Copper Pyrites, Gold Hill Mine.

	(91)	(92)	(93)
Silica	52.30 per cent.	—— per cent.	—— per cent.
Copper	0.85 per cent.	2.59 per cent.	5.96 per cent.
Sulphur	16.80 per cent.	—— per cent.	—— per cent.
Iron	23.00 per cent.	—— per cent.	—— per cent.
Gold, per ton	$25.84	$4.14	$5 68
Silver	.49	.71	2.26
Total	$26.33	$4.85	$7.94

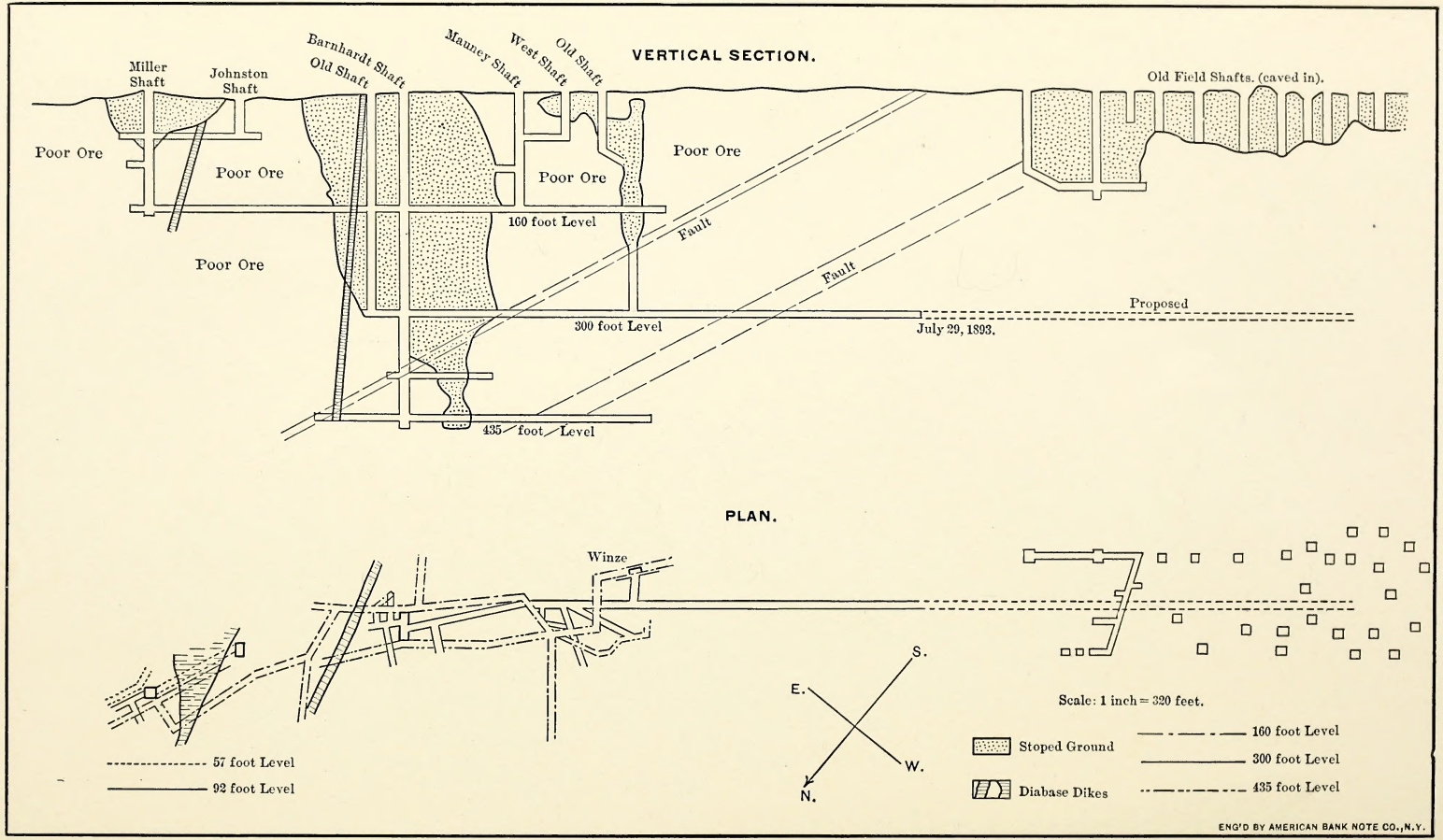
The *Barnhardt vein* (discovered in 1854) is 400 feet east of the Randolph. The ores are similar to those of the Randolph, but in general more cupriferous. (See Plate VIII.)

The *Old Field vein* lies to the southwest of the main workings of the Barnhardt; it consists of a series of ore stringers intercalated in the schists. These seams are frequently of great richness, but the gold "jumps" from one seam to the other so often as to cause some embarrassment in mining. The depth of the last workings extended to a little more than 130 feet.

The *Hunnicut* (Honeycut) *vein* is just to the southwest of the Old Field, and between the Barnhardt and Randolph. It is from 15 inches to 2 feet wide. It was discovered in 1842, nearly at the commencement of the mining excitement in this section, and was worked with great profit for a time, and to a depth of 185 feet. It is stated to have yielded $101,665.00.

The *Standard vein* is still further southwest. It consists of several narrow belts of schists charged with mineral matter. The ore body is very wide near the surface, but at greater depths becomes smaller. The deepest work was at 84 feet.

The *Trautman vein* lies on the extreme southeastern edge of the group. It was the site of the first discovery of gold in this section, in 1842. Down to 20 feet the ores were auriferous, and the deposit was originally opened as a gold mine. The ore was cellular quartz, containing decomposed sulphurets. From 20 to 60 feet down it was a mixture of hematite and highly ferruginous quartz, with a little crystallized pyromorphite, cerussite and other lead minerals; still lower down it was auriferous pyrite and quartz. At the depth of 100 feet, where the sulphurets were



GOLD HILL MINE—BARNHARDT VEIN. ROWAN COUNTY.

unaltered, the ores were poorer and contained a string of ash-grey blende and pyrite, from 2 to 6 inches wide, which had much increased at greater depths. The vein is stated[1] to have yielded $400,000.00.

The *McMakin* (or Silver) *vein* is situated in the southwest part of the district. It has been exploited by pits for several hundred yards, but the deeper workings have extended over a linear distance of about 200 feet only. No work has been done on it for over 30 years. It was entered by 3 shafts, the deepest of which was 180 feet; and two levels were driven, one at 66 feet and the other at the bottom.

There are two veins, designated as the Main vein and the Little vein. They are approximately conformable to the schistosity in strike and dip, viz.: Strike N. 45°–60° E. and dip 70°–75° S. E.

The outcrop consisted largely of brown hematite, psilomelane, pyrolusite, and dolomite—the first and second predominating. Manganese ores disappear at a depth of twenty feet; then plumbago, pyromorphite and cerussite come in; and these in turn go out at 60 feet, being replaced by galenite, blende, pyrite, chalcopyrite, and highly argentiferous tetrahedrite. The prevailing gangue is carbonate of lime and barite with quartz. Down to 70 feet yellow blende, assaying 14 to $39\frac{32}{100}$ oz. of silver, occurs in larger amounts than galenite; then the latter predominates, and is accompanied by an ever-increasing amount of tetrahedrite, and assaying 12 to $53\frac{15}{100}$ oz. silver.

The following statement by Mr. O. J. Heinrich, E. M.,[2] will show the characteristics fully: "At the depth of 76 feet between the South and the Whim shafts the vein is 4 to 10 feet wide, the vein fissure being chiefly occupied by carbonate of lime and barite."

"This gangue carries grains and small masses of tetrahedrite to a width of two feet at the southeast; the central part of the vein contains several seams of tetrahedrite and yellow blende, and the

[1] By Emmons, in 1856.
[2] In a MSS. report to the owners of the property.

northwest has yellow blende with galenite and many grains of tetrahedite. Tetrahedrite is found at its best close to the hanging wall in the southeast." Average samples according to Dr. Genth gave:

Assays, Silver Ore, McMakin Mine, Cabarrus County.

	(94)	(95)
Silver, per ton	$ 317.95	$ 646.50

"Simple cobbing increases the contents," as in assay number 95.

There is a small parallel vein west of the main vein, which has been extensively stoped, from the Whim shaft to the surface; its course is N. 50° to 60° E., and dip 35° S. E. There are probably other parallel veins, both to the northwest and southeast, for the whole belt is metaliferous.

Work was terminated at this mine in 1861, and the vein has not been touched since.

Emmons states that up to 1856 the Gold Hill Mines produced an aggregate of $2,000,000.00.

Up to 1874 it is estimated that $3,000,000.00 worth of free gold had been extracted from the ores, which represents but 20 to 33 per cent. of the assay value of the ores.

Until 1881, when a 20 stamp mill was erected, the mode of extraction was entirely by Chilian mills and rockers. The last regular operations were carried on by the New Gold Hill Company under the management of Mr. Richard Eames in 1893, when ores from the Barnhardt vein were treated in a 10 stamp mill near the mine.

Since that time work at Gold Hill has been of a spasmodic and petty character, carried on by tributers who mill the decomposed material from the old mine dumps, in the Barnhardt mill.

Although the Gold Hill ores are highly sulphuretted, no other treatment than that of simple amalgamation has been attempted to our knowledge. The yield of free gold from these ores has not been more than 20 to 33 per cent. of their assay value, as already mentioned. Chlorination has been advised, and Mr. Eames has made some experiments with cyanide, but they were never carried out on a working scale. It is more than probable that there are

still good ore bodies in the mines; certainly a careful examination is warranted, and improvements in the metallurgical treatment are suggested, namely, concentration of the sulphurets, after battery amalgamation, and subsequent treatment by a chlorination, cyanide or smelting process.

OTHER MINES IN CABARRUS COUNTY.

The Mauney Mine is situated about 1½ miles southwest of Gold Hill, on the opposite side (west) of Little Buffalo creek. The strike of the schists is N. 25° E., and the dip 75° N. W. They are soft and contain but little quartz. The ore-bearing portion is considered to be 4 feet in width. The last work done here (Nov., 1894), consisted in sinking two prospect shafts to a depth of abont 70 feet. The soft brown ores, above the water level, are stated to assay from $2.00 to $6.00 per ton.

The Isenhour Mine is several hundred yards S. 33° W. from the Mauney, and the conditions are practically the same, though there is more quartz on the hanging wall side of the deposit. Work on a petty scale has been prosecuted at this mine during the past years, the ores being treated in a Howland pulverizer, the blanket concentrates from which are washed in log rockers with quicksilver.

Among other mines in this zone of metamorphic schists, lying to the southwest of the Gold Hill region, in the eastern edge of Cabarrus county, are: the Widenhouse, Nugget (or Biggers), Eva Furr, Allen Furr, Buffalo, and Rocky River, all situated closely together, and from 10 to 12 miles southeast of Concord, the county seat.

The Rocky River Mine is situated 10 miles southeast from Concord, on the waters of Rocky river. The country rocks are sericitic and chloritic schists, soft, intermediate and highly silicified. The strike is N. 20° E., and the dip (of the schistosity) 70° N. W. There are several parallel quartz veins, which lie apparently parallel with the schistosity, but really cut it at slight angles.

The last work at this mine was done in the summer of 1895, by Mr. Wayne Darlington, E. M., who prospected the property for some Philadelphia capitalists.

The following sketch (fig. 4), shows the position of the veins and the location of the principal former workings:

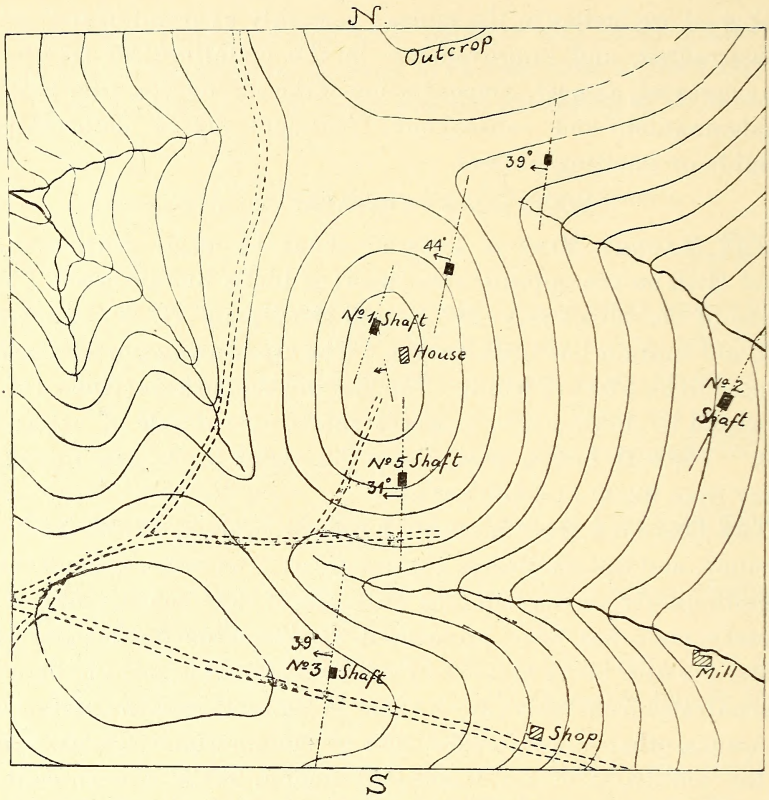


FIG. 4—Topographic Map of the Rocky River Mine, Cabarrus Co., N. C. (After Survey by Mr. Wayne Darlington, E. M. Scale 1 inch=260 feet.

Mr. Darlington's explorations were concentrated chiefly on shaft No. 1, the depth of which is 130 feet, the total length of the drifts being about 200 feet. The strike of the slates is N. 20° E.; dip 70° N. W. The strike of the vein is N. 30° E., dip 85° N. W.

In the 80 foot level the quartz was from 1¼ inches to 3 feet in thickness; in the southwest drift, about 50 feet from the shaft, it was pinched to a few inches. The pitch of the ore shoots is towards the southwest. In the 130 foot level the vein was lost altogether.

Cross cuts in the 80 foot level have exposed several small parallel veins (10 inches and less in width).

The vein matter is mainly quartz, with some carbonates, probably calcite. The quartz carries sulphurets, chiefly pyrite, with some galena, blende, and chalcopyrite. It is stated that about 50

per cent. of the gold in the ores is free milling. Apparently there are three grades of ore: (1) Rich in galena (which carries much of the gold), a smelting ore; (2) Rich in pyrites, an ore to be treated by amalgamation and chlorination; (3) Lean ore.

This quartz ore from shaft No. 1 is stated to run about $15 per ton, the richer branches of sulphurets going as high as $30.

The schists themselves are impregnated with pyrites and small stringers of quartz. In the neighborhood of the larger quartz veins these schists are stated to assay about $3.50 per ton.

At shaft No. 2 the slates are more chloritic; they strike N. 30° E., and dip 70° N. W.

In shaft No. 3 the main vein is stated to be 2 feet thick, and in the foot wall is an aggregate of narrow veins (respectively 8 to 10 inches thick) comprising together a width of about 3 feet.

In shaft No. 5 the vein is stated to be 5 feet thick.

Assays of the Rocky River mine ores show:

Assays, Gold Ores, Rocky River Mine, Cabarrus County.

	(96)	(97)	(98)	(99)
Gold, per ton	$ 5.17	$ 17.05	$ 56.85	$ 64.59
Silver, per ton	1.04	trace	7.18	3.66
	$ 6.21	$ 17.05	$ 64.03	$ 68.25

The recent explorations of Mr. Darlington have apparently shown that the quartz veins, themselves, while of good quality, cannot be depended on in regularity of extent. It may be that similar lenticular shoots exist in depth. However that may be, the adjoining schists are known to be auriferous for some distance from the quartz veins, and, taken together with the quartz, may make large bodies of low grade ore.

If the mine were attacked from this view it might be worked profitably.

The Buffalo Mine is situated one mile northeast from the Rocky River. The slates strike N. 55° E., and dip 80° to 85° N. W. The main vein is quartz, 5 feet in maximum width. The slates have been cut in a shaft and crosscut over a width of about 25 feet, and found to be pyritic, assaying $3.50 per ton in gold, of which about $1.00 is free gold.

The Allen Furr Mine is 11 miles southeast of Concord, and

near the Rocky River. The ore carries a small proportion of galena in a gangue of massive pyrite; occasionally the galena occurs free enough to constitute a true lead ore. But it is doubtful if any considerable amount proves so rich as indicated by the following assays:

Assays, Gold Ores, Allen Furr Mine, Cabarrus Co.

	(100)	(101)	(102)
Gold, per ton	$ 5.17	$ 6.20	$ 24.81
Silver, per ton	2.58	1.23	26.89
	$ 7.75	$ 7.43	$ 51.70
Lead			34.18 per cent.
Zinc			small per cent.

The great size of the lumps of ore and their richness in pyrites had attracted some attention to the locality as a source of sulphur for the manufacture of sulphuric acid, but later examination have not borne out this expectation.

The Nugget or (Biggers) Mine is situated 12 miles southeast of Concord. The country rock is argillaceous slate, which is intersected by basic dykes. An ancient gravel channel of some extent has been worked here for the past two years by hydraulicking. The gold is usually quite coarse and in nuggets. Some galena-bearing quartz veins have been superficially explored, but never developed.

MINES IN UNION COUNTY.

These mines are located in the western part of the county. The ores are readily classified into auriferous and argentiferous galena, auriferous pyrite, and auriferous schists; but sulphurets are never absent from the latter. Copper ores are of incidental occurrence, but are not known to be present in quantity.

The Crowell Mine is situated about 14 miles (air line) north of Monroe, in the extreme northwestern corner of the county. The vein matter is cellular quartz, carrying a little galena, some pyrite, and a trace of chalcopyrite.

There are 3 veins. No. 1 strikes N. 30° E., and dips steeply to the northwest. In thickness it varies from 1 to 4 feet. The old engine shaft is 80 feet deep, with drifts 50 feet northeast and 60 feet southwest.

Some assays show the following results:

Assays, Gold and Silver Ores, Crowell Mine, Union County.

	(100)	(101)	(102)	(103)	(104)	(105)	(106)	(107)	(108)
Gold, per ton	$ 3.51	$ 5.17	$ 8.28	$ 9.30	$ 9.30	$ 10.34	$ 32.04	$ 31.00	$ 41.34
Silver, per ton	9.95	1.29	3.46	3 42	10.21	3.55	.32	55 34	4.85
	$13.46	$ 6 46	$11.74	$12.72	$19.51	$ 13.89	$ 32.36	$ 86 34	$ 46.19

The middle vein is 1,000 feet east of and parallel to No. 1, but it is narrower.

Vein No. 2 is 1,500 feet still further east; it varies from 2½ to 4 feet in width; its dip is from 40° to 45° northwest.

THE LONG MINE is ¾ mile southwest of the Crowell, and apparently in line with the easternmost or No. 2 Crowell vein. The strike is N. 50° E., and dip 85° N. W. The vein matter is quartz and schist which carry pyrite, with some galena, sphalerite and chalcopyrite. Calcite and siderite occur as gangue minerals. The thickness of the vein is reported to be 30 inches to 4 feet.

THE MOORE MINE is 3 miles southeast of the Long. The country rock is chlorite schist, which strikes N. 50° E., and dips steeply to the northwest.

The mine has been opened by a shaft 80 feet in depth, but is now inaccessible. The former superintendent, Mr. R. J. Wentz, states that the ore body consists of a quartz vein 5 feet in thickness, approximately conformable to the schistosity of the country rock; and that a four-inch paystreak, composed mainly of calcite carrying free gold, follows the hanging wall.

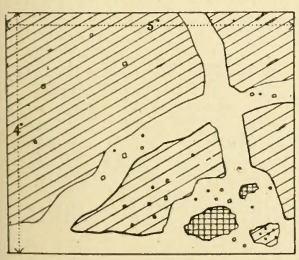


FIG. 5, Showing fragments of schist in vein matter, both containing sulphurets.

The quartz carries pyrite, chalcopyrite, galena and much blende. These sulphurets also extend into the wall rock. The schists are intersected by narrow seams (⅛ inch) of calcite.

Specimens were found on the dump showing fragments of the country schist, highly silicified, imbedded in the vein matter, in both of which are contained small crystals of the sulphurets (fig. 5). Hence the quartz veins were formed in openings in the schist, the whole mass becoming at the same time mineralized.

Other specimens were found showing fissures in the silicified schist containing quartz, well crytallized along the walls, and protruding at right angles to the same; the interior being filled with fine granular calcite, and some well crystallized calcite rhombohedrons. Small specks of a light brown mineral, probably siderite, are distributed in the calcite and against the quartz. The quartz contains crystals of chalcopyrite. (See Fig. 1, page 50.) This shows that quartz was crystallized first around chalcopyrite, and then siderite, followed by calcite. Assays of these ores give the following results:

Assays, Gold Ores, Moore Mine, Union County.

	(112)	(113)	(114)
Gold, per ton	$ 8.27	$ 20.67	$ 124.02
Silver, "	1.52	2.33	116.86
	$9.79	$23.00	$240.88

The Stewart Mine is situated 1½ miles southwest of the Moore, on Goose creek. The country rocks are argillaceous and sericitic schists. Their strike is N. 55° E., and dip 85° N. W. These schists vary from soft to semi-silicified types, and at times show banding at angles to the schistosity. The ore bodies consist of certain belts of the country rock, impregnated with auriferous quartz stringers and sulphurets (pyrite and some galena). There are three such parallel ore belts, the Asbury, Miller, and Jake. The *Asbury* is farthest southeast, and is reported to be from 4 to 18 inches wide. It has been explored by a shaft 80 feet in depth. The *Miller* is 15 feet northwest from the Asbury, and is reported to be 5 ft. wide. It has been explored by a shaft 185 ft. deep, from the bottom of which drifts extend 100 ft. southwest and 30 ft. northeast, stoped to within 20 ft. of the surface. A cross cut runs from this shaft to the *Jake* "vein," 6 ft. northwest, which has been drifted on 50 ft. southwest and stoped to within 20 ft. of the surface.

In general, the seams of ore are narrow, but there are many of them; and it may be questioned whether the whole series is not one and the same ore belt, with several productive channels. There are also two heavy quartz veins near the Miller and Jake veins, one of them 12 feet wide, but externally not promising.

A ten stamp mill stands on the property, and when visited (Nov., 1894,) was being operated under extremely adverse conditions on material from the old mine dump, consisting of soft, brown gossan ores, which was reported to yield $13 per ton.

Assays of ores containing galena show:

Assays, Ores from Stewart Mine, Union County.

	(115)	(116)	(117)	(118)	(119)	(120)	(121)
Gold per ton,	$ 3.10	$ 8.27	$33.07	$41.34	$41.34	$44.44	$219.10
Silver "	14.09	.93	5.71	6.59	4.01	5.75	5.68
	$17.19	$9.20	$38.78	$47.93	$45.35	$50.19	$224.78

The lead was not determined, but enough was present to form a desirable constituent in smelting.

Other assays from this mine show:

Assays, Ores from Stewart Mine, Union County.

	(122)	(123)	(124)
Gold, per ton	$5.17	$12.40	$20.15
Silver, "	.91	.04	.25
	$6.08	$12.44	$20.40

The future of the mine will probably depend on the possibility of working comparatively low grade ores, and of concentrating the sulphurets for subsequent metallurgical treatment. A very rich shoot of ore was found, but it was subsequently lost, and a great deal of costly work has been expended in searching for it.

The Lemmonds (or Marion) Mine is a southern extension of the Stewart. Prof. F. A. Genth, who had the opportunity of examining the underground work at this mine, describes the vein as follows: " Irregular in size, sometimes widening out from a few inches to 6 feet. It consists of quartz richly charged with brown zinc blende and galenite, with small quantities of arsenopyrite, chalcopyrite, etc."

A pure specimen of galenite which did not show any free gold (assay No. 125), and one of brown zinc blende (assay No. 126), were assayed by Genth, with the following results:

Assays, Ore from the Lemmond's Mine, Union County.

	(125)	(126)
Gold, per ton,	$620.10	$330.72
Silver, "	111.84	20.69
	$731.94	$351.41

A more recent assay of a probably more nearly average sample of ore from the same mine shows:

Assay of Ore, Lemmond's Mine, Union County.

	(127)
Gold, per ton	$3.10
Silver, "	6.80
	$9.90

The New South Mine is 1½ miles northeast from the Stewart. The work down to 25 feet was satisfactory and profitable. The slates are laminated and thoroughly altered, but at that depth the alterations nearly ceased, and the "blue slates" came in, i. e., drab colored slates with disseminated pyrites. In the miners' parlance the gold " went out," which is merely a practical observation that the gold could not be profitably extracted by the ordinary way of milling or panning.

The Crump Mine is situated 2½ miles southeast of the Stewart in Vance township. It has been worked for a length of 300 yards and was entered by three shafts. The vein matter (slates with some quartz and a little disseminated pyrites) was examined, and the very best and most promising sample of the supposed workable ore assayed with the following result:

Assay, Gold Ore, Crump Mine, Union County.

	(128)
Gold, per ton	$6.41
Silver, "	trace
	$6.41

This would indicate very low grade ore for the general run of the mine, but it is noted for its remarkable pockets, and splendid and peculiar nuggets, in which nearly all the gold occurs.

The Butterfield Mine is 150 yards to the northwest of the Crump. It has been worked to a depth of 75 feet. The quartz carries copper and iron pyrites.

There are a number of mines in the vicinity of Indian Trail station on the Carolina Central railroad.

They are apparently located in two parallel series about ½ mile apart, comprising in the first or western group the Henry Phifer and Fox Hill mines, and in the second or eastern the Black, Smart, Secrest and Thomas Hemby mines.

The strike of the schists is about N. 30° E., and the dip nearly vertical.

The Henry Phifer Mine is ¼ mile north of Indian Trail. The property comprises a long and narrow tract of 2,000 feet. The veins are stated to have been productive, but no record of the work is now at hand.

The Fox Hill Mine is one mile northeast of the Henry Phifer. The remnant of the vein could recently be seen in the walls of the shaft, and appeared to be 6 to 10 inches in width, consisting of quartz, brown ore and iron pyrites. It has been sunk upon to a depth of 40 feet. The slates strike nearly north and south where observed, and dip slightly eastward.

The Black Mine is ½ mile nearly east from Indian Trail. There are two veins, or two seams of one and the same vein, only one of which could be examined. It was filled with quartz, and varied from 10 to 30 inches in width, so far as could be seen, although the full width is reported to be 4 feet, with rich seams of mineral matter from ten inches in thickness down to a mere seam. The strike is a little east of north, and the dip slightly eastward. A cross vein is also reported. The mineral matter of the rich seams is of high grade as shown by the following line of assays. It consists of galena, with very little blende, and iron and copper pyrites:

Assays, Gold Ores, Black Mine, Union County.

	Free milling		Sulphurets.		
	(129)	(130)	(131)	(132)	(133)
Gold, per ton	$ 10.33	$ 60.97	$ 98.19	$ 117.82	$ 165.36
Silver, per ton	.45	2.33	3.75	.06	3.81
	$ 10.78	$ 63.30	$101.94	$ 117.88	$ 169.17

Assays of Galenas, Black Mine.

	(134)	(135)
Gold, per ton	$ 42.37	$ 41.34
Silver, per ton	5.56	8.14
	$ 47.93	$ 49.48

The mine workings consist of a shaft 60 feet deep, from the bottom of which a drift extends 30 feet north and 40 feet south.

The Smart Mine is one mile N. 30° E. from the Black. The country rock is sericite schist, in part highly silicified, which strikes N. 30° to 40° E., and stands nearly vertical. The ore is galena with pyrite in a matrix of quartz; it had been found in some quantity, but the last work in 1888 did not uncover so large a quantity as was expected. The ore body has been proved to a depth of 110 feet, and three levels at 35, 60 and 95 feet respectively have been run, each of which is about 60 feet in length. The

vein is at times 3 to 4 feet thick, but the width of the ore seam is considerably less. Assays show the following values:

Assays, Gold Ores, Smart Mine, Union County.

	(136)	(137)	(138)
Gold, per ton	$ 12.40	$ 13.44	$ 46.51
Silver, per ton	3.94	2.07	5.95
	$ 16.34	$ 15.51	$ 52.46

THE SECREST MINE is ¼ mile northeast of the Smart. The schists are argillaceous to chloritic, striking N. 30° to 35° E., and dipping slightly westward. No reliable information is available respecting its resources. There is another mineral occurrence on the Secrest property, ¼ mile west of the above locality, namely, a northeast and southwest running vein (N. 35° E., with steep westerly dip), with an 8-inch seam of brown ore; and running from it in a westerly direction with steep northerly dip is a quartz vein, carrying galena and chalcopyrite, and varying in width from 2 to 12 inches.

Assays of ores from this mine give the following results:

Assays, Gold Ores, Secrest Mine, Union County.

	(139)	(140)
Gold, per ton	$ 2.07	$ 67.18
Silver, per ton	16.73	5.04
	$ 18.80	$ 72.22

No. 139. From northeast and southwest vein. No. 140. From east and west vein.

About 2 miles north of Indian Trail, on the road from the Smart to the Stewart mine, a heavy debris of a felsitic eruptive rock occurs. It was not found in place.

THE MOORE HILL, FOLGER HILL, DAVIS, PHIFER, LEWIS, HEMBY GROUP OF MINES.

About 2 miles south of Indian Trail is situated a group of mines, comprising the Moore Hill, Folger Hill, Davis, Phifer, Lewis, Hemby and Harkness.[1] The relative position of these mines is shown in the accompanying sketch map (Fig. 6).

[1]Geological Report of the Midland Counties of North Carolina, 1856. E. Emmons. p. 167.

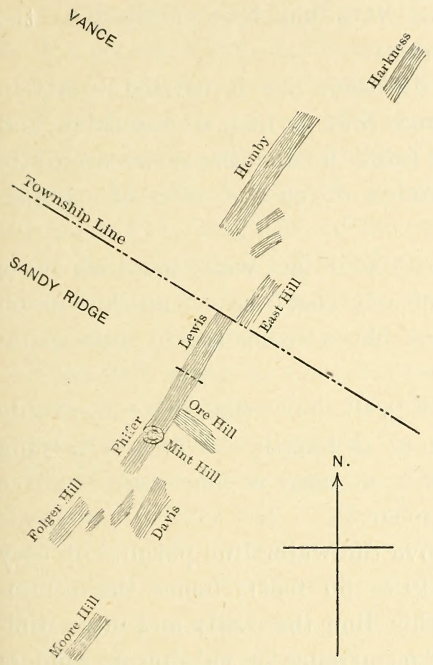


FIG. 6. Sketch map showing relative locations of the Davis, Phifer, Lewis, Hemby, etc., mines, Union county.
Scale of longitudinal distances: 3 inches=1 mile. The transverse distances are slightly exaggerated.

This zone of auriferous schists is 3 miles in length and not much less than one-half mile in width, some parts of which are capable of being operated, and some parts not, but none absolutely barren.

Occasional pits both to the east and west of the line of work indicate that the zone is in reality much wider, but not commercially workable, so far as yet prospected. Beyond the Hemby and Harkness, immediately to the northeast, little has been found, and the location of the "Big Survey" lands have prevented prospecting to the southwest.

For a distance of nearly two miles there is an almost unbroken series of pits and shallow shafts. This vast number of diggings is the result of petty leases (which will also account in great part for the shallowness of the pits), and incidentally bears witness to the value of the deposits, which have been very rich, especially on the Phifer tract, where on Mint Hill an open cut, 100 feet in diameter and 50 feet deep, was worked out. Petty work is constantly going on along the whole line, but none of the mines are being systematically operated.

The country rock is an argillaceous schist, which strikes N. 20° to 45° E., and stands nearly vertical, dipping slightly easterly in some places and westerly in others, the latter prevailing. These schists vary from soft to very highly silicified types. They are impregnated with finely divided iron pyrites up to 1 or 2 per cent.; small lenses of pyrite and calcite also occur; and quartz stringers are frequent.

The occurrence of diabasitic dikes has been noticed at the Phifer, Hemby and Harkness mines.

The gold is not uniformly diffused, but is carried mostly in narrow, parallel seams, rarely more than an inch or two thick, and sometimes not thicker than a knife blade; the seams are quite porous and discolored with peroxide of iron and oxide of manganese above the water level.

The ore bodies as a whole are 1 to 6 feet wide, in which these seams occur abundantly and closely together. And the barren ground is that portion in which these seams are of infrequent occurrence.

A glance at the sketch map (Fig. 6) shows that these workable belts are frequently not continuous in length. A new belt, lying parallel to the first may appear; or, after a short unproductive interval, the same belt may reappear.

The softness of the schists above the water line permits of easy and cheap work to this depth (40 to 50 feet); hence the innumerable shallow pits; but below this line the costly and more difficult nature of the work and the occurrence of sulphurets renders mining and milling more difficult, so that the ore bodies below this depth are still largely intact.

The Moore Hill tract has been worked 100 feet in length, and at the most 70 feet in depth.

The Davis has been worked fully 500 feet in length, and to a maximum depth of 150 feet in the "Road" shaft.

Folger Hill has been worked some 300 to 400 feet in length. Random samples of rejected ore from the surface gave:

Assay, Rejected Gold Ore, Folger Hill, Union County.

(141)

Gold, per ton	$4.13
Silver, per ton	.22
Total	$4.35

The Phifer (or Price) Mine is situated in a belt at least 100 feet west of the Davis, and has been worked for a length of 400 feet and to a depth of 100 feet. Very rich stringers have been found here. Mint Hill is a fine illustration, for so abundant and rich were the stringers that the whole material for 100 feet in each direction and 80 feet in depth was taken out and milled.

At Ore Hill a system of cross fissures (strike S. 33° E.; dip 57° N. E.) occurs, which has been worked to a depth of 80 feet.

The Lewis Mine has been worked nearly 1,000 feet in length and to a depth, in places, of 80 feet.

The fineness of the gold at the above described mines is of low grade. The Davis gold is sometimes not worth more than 35 cents per dwt., and little of the gold will exceed 75 cents. Moreover, the occurrence of stringers near each other with gold of quite varying values points to dissimilar conditions of original deposition. Galena in sparing quantity occurs at times.

East Hill, lying to the northeast of the Lewis, has apparently a position to the east of the extension of the Lewis belt. It carries a great deal of heavy quartz.

The Hemby Mine appears to lie slightly to the west of the Lewis and Phifer lead. The shallow workings extend for a distance of 1,200 to 1,500 feet along the strike. There are two shafts here over 100 feet in depth. The old mine dumps show much solid, glassy quartz. Siderite occurs as a gangue mineral.

Several non-parallel bodies exist on the property. Samples from some recently exposed, but ordinary looking seams of ore assayed:

Assays, Gold Ores, Hemby Mine, Union County.

	(142)	(143)
Gold, per ton	$3.10	$15.71
Silver, per ton	.21	.86
Total	$3.31	$16.57

The Harkness Mine is 1½ miles northeast of East Hill, and from its position and the nature of the ore (heavy quartz) it appears to be a continuation of the latter. It has been worked for a length of 300 feet, and to a reported depth of 120 feet. The strike is N. 20°–25° E. The ores, so far as they could be examined, are very quartzose, containing coarse gold of relatively high grade.

THE BONNIE BELLE AND HOWIE GROUP.

A group of mines of some importance, consisting of the Bonnie Belle and Howie, is situated some 6 miles south of the Davis, Phifer, Lewis, etc., group, and about eight miles west of Monroe.

The Bonnie Belle (or Washington) Mine is 1½ miles north of Potter's Station, on the Georgia, Carolina and Northern R. R.

The country rock is argillaceous schist, varying in degree of hardness from soft to highly silicified. The strike is N. 55° E., and the dip steeply westward. At one point an obscure outcrop of mica gneiss was observed. The schists show banding both with and across the schistosity, pointing to their sedimentary origin.

A diabasitic dike intersects the country nearly at right angles; it is reported to be 10 feet in thickness, dipping 40° to 45° S. W. The schists are impregnated with finely divided sulphurets, chiefly pyrite and some little chalcopyrite. Small specks of free gold occur as coatings on the major cleavage planes. Very small quartz veinlets intersect the schists at various angles. The general width of the ore bearing belt is stated to be 14 feet, and it has been proven over a distance of at least ¼ mile along the strike, besides being traced much farther by pan tests. There are also indications of other parallel ore bodies but these have not yet been prospected. When visited, in the fall of 1894, the mine was being operated experimentally, and the ore treated in a combination Chilian and four dragmills, which discharged on amalgamated copper plates, and thence to a Gilpin county bumping table for concentration. The capacity of the mill was 10 tons per 24 hours.

The shaft from which the ore was raised is located near the mill. If was about 20 feet deep at the time when visited. The thickness of the ore body in this shaft was from 5 to 8 feet, the richer portion lying in the 2 feet adjoining the hanging wall. Samples of the ore were taken from the crusher at the mill, also of the concentrates and tailings, and the assays by Dr. Chas. Baskerville show:

Assays, Bonnie Bell Mine, Union County.

	Ore.	Concentrates.	Tailings.
	(144)	(145)	(146)
Gold, per ton	$4.13	$20.67	trace
Silver, "	1.42	1 94	$ 1.03
	$5.55	$22.61	$1 03

The Howie Mine[1] is situated about 1 mile south of west from

[1] Geological Report of the Midland Counties of North Carolina. 1856. E. Emmons; p. 133.

the Bonnie Belle. The country rock is a dark colored argillaceous slate usually highly silicified. The strike is N. 55° E., with a very steep dip to the northwest.

The ore bearing formation is said to extend over a width of 400 feet, and fully a mile in length. Within this belt there are perhaps as many as 8 so called "veins" or ore seams, varying from 18 inches to 16 feet in width. It is difficult, however, to say where "vein" matter is not found, as the rocks of the entire region are gold bearing. The mine stuff rarely shows by its external appearance what material is and what is not rich enough for remunerative work, and this is determined by constant tests.

Pyrite to the extent of about one (1) per cent. is widely disseminated, and occurs somewhat more abundantly on the cleavage faces and joints of the slates. The slates are penetrated by numerous seams of quartz, which generally have the effect of enriching the ore body. Free gold occurs as fine films on the cleavage and joint planes of the slates.

Cross-fissures occur in the mine, filled with a "reibungs-breccia" of slate fragments cemented by pure white crystalline calcite. Small calcite veinlets penetrate the slates in various directions.

Diabase dikes are of frequent occurrence; they strike in a northwest direction across the slates. It is stated that the ore is richer in the vicinity of these dikes. The mine is inaccessible, but as the rock is extremely hard most of the shafts, although filled with water, are still intact. The deepest shaft was the Cureton, 300 feet deep.

The ore, as might be supposed, runs through a wide range of values. The former superintendent, Mr. I. Bates, reported that the average ore will yield in the mill about $13.00 per ton. The average of 12 assays of the "soft" ore (above water level) by Prof. Spears, of New York, gave for the gold and silver contents a value of $14.60 per ton; and the rubbish piles were shown by him to carry $3.25 per ton. An examination of various tailing dumps showed that a surprising amount of gold was lost in the mill work.

As already mentioned on p 36, the Monroe slates are intersected by quartz fissure veins. These veins are in instances auriferous, and at several points a short distance west of Monroe, prospects of gold have been discovered and superficial explorations made, but presumably without much success, as they were never pursued to any extent and are now abandoned.

ANSON COUNTY.

The Hamilton (Bailey) Mine is situated 2 miles southeast of Wadesboro. There are two quartz veins of which the westerly was formerly worked to a depth of 100 feet; it is stated to be 2½ to 4 feet in thickness. Assays have shown variable values from $4.00 to $30.00 per ton.

The Jesse Cox mine is in the same vicinity.

CHAPTER V.

THE CAROLINA IGNEOUS BELT AND ITS GOLD DEPOSITS.

GENERAL DESCRIPTION OF THE BELT.

The Carolina Slate Belt is bounded on the west by an area of massive, igneous, plutonic rocks, extending across the State in a southwesterly direction, and having a width of 15 to 30 miles. This is the Carolina Igneous Belt of gold bearing rocks. It includes the greater portion of the counties of Guilford, Davidson, Rowan, Cabarrus, and practically the whole of Mecklenburg. The area of the auriferous portion, however, is scarcely more than 1,000 square miles. At the northeast, in Guilford county, the mines occur near the southeast edge of the belt, and near the schists; this relative position they hold as far south as Rowan county, where they begin to appear at a considerably greater distance from this border, and finally in Mecklenburg county, near the southern boundary of the State, they stretch nearly across the entire area of igneous rocks from east to west. It may be said, with almost absolute accuracy, that the mines are on the east side of the main line of the Southern Railroad to a point little further south than Concord, where the mineral belt crosses the railroad abruptly and spreads to the westward.

GEOLOGIC CHARACTERISTICS.

The rocks are, so far as macroscopic determinations go, granitic, dioritic, gabbroitic, and diabasic eruptives, sometimes passing into each other by gradual transition phases. Schistose or gneissic structure is developed in places, as in the vicinity of Lexington, Davidson county, where the strike is N. 20° E., and the dip, as a rule steeply westward.

From the nature of the contact, it appears that the age of this igneous mass is younger than the slates and schists of the Carolina Slate Belt on the east.

Diabasic and granitic dikes again intersect the main igneous mass, and are therefore still later intrusions. These dikes are

sometimes indistinctly schistose in the same direction as the schistosity of the enclosing rock, where such is developed, which would indicate that they were intruded before the force producing schistose structure was active. Furthermore they are often finer grained towards the edges than in the centre. In places they split, sending off cross-dikes. But as a rule they are more regular in outline, and in width may vary from a few inches to many feet.

The auriferous quartz veins, which are found in these rocks, are the fillings of fissures. These fissures, particularly where they occur within a more or less homogeneous mass, are quite regular in outline, as at the Reed, Phœnix and Reimer mines. On the other hand, in some instances, they appear as pocketed or lenticular bodies, as at the Surface Hill mine, along the contact of a diabase dike with the granite. In still other places the quartz veins are confined to the diabase, as at the Phœnix mine.

If this diabase is in itself the filling of a dike fissure the age of the gold veins must be subsequent to the dike formation, a fact which does not agree with that found to exist in the Carolina Slate Belt, where the diabase dikes intersect the ore bodies. And it would thus appear that there were two eras of dike formations. However, the true relations of the rocks could not actually be determined at the Phœnix, as the mine was inaccessible, and the rocks could not even be seen in place. In fact, the diabase dikes in North Carolina might even be referred to three ages, including those which are found in the Jura-Trias, and which must hence be post Jura-Triassic. These are, however, but suggestions which are subject to modification on further research. They simply present a line for investigation.

THE ORE DEPOSITS OF THE CAROLINA IGNEOUS BELT.

It seems clear that the genesis of the gold ores in these igneous rocks must be ascribed to the ascension of mineralized waters.

These gold ores are often cupriferous; they rarely contain any notable amount of lead, zinc, or nickel; the silver present is usually alloyed with the gold; arsenic and antimony are not com-

mon, and the ores are refractory only as the sulphurets make them so.

The chief filling of the fissures is quartz, carrying the auriferous sulphurets. Frequently a finely laminated argillaceous or chloritic slate is noticed in the filling, parallel to the walls of the veins; it is sometimes within the quartz itself but, but generally nearer the walls, shading gradually into the country. The presence of these slates in a vein, where there is at best but slight development of schistosity in the enclosing country rock, is an interesting phenomenon. In depth the slaty structure does not exist, or becomes obscured.

In many mines there is what is called a back and a front vein (occasionally a middle vein also), but all evidence goes to show that they are but parts of the same vein.

The quartz frequently shows a banded structure, especially near the walls ; and there is often a parallelism in the occurrence of the sulphurets.

The frequent cupriferous nature of the ore in this belt has been alluded to. The copper ores, unless they were of such exceptional richness as to bear costly land transportation, had no market, and the time came when the price of copper fell so low as to preclude the working of these ores for copper alone. The low grade copper ores, which (in sections favored with cheap transportation, or near commercial centres) could be easily beneficiated by concentration, were here valueless ; and as it was found by experience that the presence of copper greatly hindered the amalgamation of the gold ores, for which these mines were in every case originally operated, the presence of any considerable amount of copper was the signal for abandoning the mine. It is also quite true that copper pyrite, as a rule, does not carry as much gold as iron pyrite.

It is not probable that the ores of copper are likely to be of importance for the exclusive production of that metal in the present condition of the copper market ; but in a smelting treatment of the gold ores of this section (particularly the complex sulphurets), the command of a large supply of auriferous copper

ores is almost essential to the prosperity of many of the mines of central North Carolina.

THE MINES IN THE CAROLINA IGNEOUS BELT.

MINES IN GUILFORD COUNTY.

The mines of this county lie to the south and southwest of Greensboro. They carry highly cupriferous ores, and have been worked both for gold and copper. Emmons described these mines in 1856,[1] and a brief condensation, with some rearrangements and additions, is made from his report, as a matter of convenience to those who have no opportunity to consult the same.

The Hodges (or Hodgins) Hill Mine is situated 6 miles southeast from Greensboro, and lies near the western edge of the granite. The vein is stated to strike a little west of north and to dip to the southwest, 400 feet on the slope making hardly more than 100 feet in vertical depth. It is from 6 inches to 12 feet in width. Pits have been sunk along the outcrop for a distance of 800 to 900 feet. The gold is distributed unequally through quartz and chalcopyrite. Other gangue minerals are pyrites, siderite, manganese oxide and limonite. The alteration copper minerals are malachite and red oxide. Various assays show the following:

Assays, Ores from Hodges Hill Mine, Guilford County.

	(147)	(148)	(149)	(150)	(151)
Gold, per ton	$ 1.03	$ 2.07	$ 11.36	$ 22.74	$ 45.47
Silver, per ton	trace	trace	trace	trace	.58
	$ 1.03	$ 2.07	$. 11.36	$ 22.74	$ 46.05

Samples for assays Nos. 147 and 148 are from the poorest brown ore to be found on dump Sample for assay 149 was from the best appearing oxidized, cellular siderite from dump. Sample for assay 150 was from the screened and partly concentrated ore. Sample for assay 151 was taken from the most prominent iron pyrites obtainable from the dump.

The Fisher Hill and Millis Hill Mines are 5 to 6 miles slightly west of south from Greensboro, and two miles west of the Hodges Hill. The mining tract comprises 900 acres. Fifteen veins are reported on the property. One system runs approximately north and south, and a second nearly northeast and southwest. The main work was done at three points; Fisher Hill; Millis Hill, nearly 150 rods south; and the Puckett vein, towards the southern extremity of the property. The dip of the two Hill veins is very

[1]Geological Report of the Midland Counties of N. C., 1856. E. Emmons. pp. 170-175; 196-204.

flat, from 15° to 20°. The Fisher Hill vein carries a little copper; Millis Hill a somewhat larger quantity; and the Puckett a considerable amount, with a heavy percentage of iron pyrite.

The aggregate length of the veins on this property is perhaps not less than 8 or 10 miles, though not everywhere capable of being worked under existing conditions. The vein which was most extensively worked is traceable for nearly a mile, and has been successfully operated at several points. The ore body varies from 4 inches to 10 feet in thickness, and carries relatively high grade milling material. Four levels, aggregating nearly 200 feet, have been run. The milling plant consists of 10 stamps, and was in operation in 1886 and 1887.

The Twin Mine is situated 6 miles southwest from Greensboro. It derives its name from the fact that two parallel veins are exposed in one tunnel. These veins have a strike of N. 40° E., with a southeasterly dip. The slate between the veins is 4 feet thick, and the veins about 18 inches, consisting of quartz carrying chalcopyrite.

The Raleigh vein is a continuation of the Twin.

The North Carolina (or Fentress) Mine is situated from 9 to 10 miles south of Greensboro, and near the eastern edge of the igneous belt. The old mine dumps bear witness to the size of the vein, as well as to its length, for it has been traced some 3 miles along the outcrop; though the part which was actively worked does not exceed ½ mile in length. It has been entered by 3 deep shafts, and by a great number of shallow shafts and pits. The strike is variable from N. 25° E. to more easterly; the dip is westerly from 38° to 60°. The main, or Engine shaft, is 400 feet deep, partly vertical (possibly 330 feet), and partly on the underlay. Four levels have been run from 300 to 500 feet in length.

In the Worth shaft, at the extreme southwesterly end of the vein, the ore body is 3 to 4 feet thick at the depth of 40 feet; at the extreme northeasterly end it is 3 feet thick at a depth of 55 feet; while at the Colby shaft it is 1 foot thick at a depth of 40 feet. At 310 feet the fissure is from 7 to 13 feet wide between the walls. There is, however, no improvement in the

vein where it is expanded, and it carries no more copper than when 7 to 8 feet thick. The copper sulphurets shift in position, lying upon the footwall for 30 to 40 feet, then suddenly curving upwards and following the hanging wall for a distance of 20 to 30 feet; or without a curve, they suddenly leave one wall and take to the other. Occasionally they occur in nests or solid masses 18 to 20 inches long by 7 to 8 inches thick. The vein stone is quartz and carbonate of iron.

In 1855-56, when the mine was last worked on any considerable scale, it had a high degree of prosperity, and shipments of copper ore, for which it was then exclusively worked, amounted to 1,400 or 1,500 tons, ranging from 14 to 23 per cent. copper. The shoot then worked lay upon the footwall side, just above the 310 foot level, and had a maximum width of 34 inches. The following assays represent samples taken from the old mine dump:

Assays, Ores from the North Carolina (or Fentress) Mine, Guilford County

	(152)	(153)
Gold, per ton	$ 0.62	$ 6.20
Silver, per ton	———	.77
	$ 0.62	$ 6.97

No. 152. Carbonate of iron, which appears to contain practically no gold, except when pyrites are casually intermixed.
No. 153. Iron pyrite, with a trifling per cent. of copper.

The Gardner Hill Mine is 2 to 3 miles a little to the north of east from Jamestown. Comparatively little work has been done here since Prof. Emmons examined the mine in 1856, and the following extract is taken from his report[1]:

"It is a true vein, whose direction is N. 20° E., with a westerly dip. * * * * The gangue is quartz intermixed with brown ore, which lies against the footwall, and is from 6 to 12 inches thick. * * * The lode is bounded by slate or killas; but the adjacent granite on the lower or footwall is extremely tough and hard, while that on the upper side is soft. The arrangement of the vein stone is shown in Fig. 8. *a. a.* the granite enclosing

[1] Geological Report of the Midland counties of North Carolina, 1856, pp. 174-176.

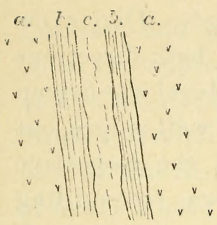


Fig. 8. Showing structure of the vein fissure at the Gardner Hill mine.

the vein fissure; *b. b.* killas or slate; *c.* vein. The vein fissure is rarely more than 3 feet wide near the top, and in a part of the lode at the depth of 80 feet it is only 8 inches, where the ore is poor. The vein stone is quartz as is commonly the case in granite, but upon each side it is bounded by slate, which of course fills in part the fissure. * * * * The gold bearing oxide is derived from the copper and iron pyrites. It seems, therefore, that the gold attaches itself, as usual, to the sulphurets. * * * * The Gardner mine, at the depth of 110 feet, yields, under careful management, about one dollar per bushel[1], the poorest about fifty cents. The ore contains a handsome quantity of rich sulphuret of iron and copper; it yields about 30 per cent. of copper; it is not largely intermixed with iron pyrites at any part of the vein. There are probably three veins upon the Gardner property, but I have been unable to determine their relations."

The following facts have been elicited by the present survey:

The vein has been worked for a length of 5,000 feet along its course, from the Creek shaft on the northeast to the White Oak shaft on the southwest, but the main work has been confined rather to the southerly part of the property.

The following shafts have been sunk, and in the order named:

The Creek shaft, 110 feet deep, on the underlay. The ore body was 6 to 8 inches wide, consisting of iron and copper pyrites in quartz.

The Underlay shaft, 600 feet southwest, is 175 feet deep on the incline.

The Old Engine shaft, some 400 feet from the south end of the property is 175 feet deep, vertical.

The New Engine shaft, still farther southwest, is 258 feet in depth, vertical. No. 2 shaft, 250 feet southwest of the above, is 110 feet deep, vertical.

The White Oak shaft at the southern boundary of the property, is 150 feet deep, vertical.

[1] Twenty bushels to the ton, approximately.

There are four levels at 60, 100, 150 and 228 feet. They average 500 feet in length, and have been driven in both directions from the shafts, with the exception that no south level was driven from the White Oak shaft. The mine is pretty well stoped out from the water level (60 feet) to the bottom of the respective shafts. Down to the water level the product was free-milling brown ore; from the water level on it runs into copper sulphurets.

When copper ore was encountered in quantity little further effort was made to extract the gold; shipping ores of copper were exclusively sought after, and for many years a very high degree of prosperity was enjoyed; it is stated that for a long period 40 tons of yellow copper ore were shipped weekly, averaging from 20 to 25 per cent. copper. The width of the veins at times was fully 20 feet.

It has been stated that there are three veins on the property. A few feet back of the Main vein is the Worth vein, which is supposed to have been worked out, from the surface down. It is claimed to have been very productive, and to have enriched the owners and lessees, but no records are in existence.

Another small vein (the Goshen) lies some 200 to 300 feet behind the Main vein, but the Survey is unable to make any further statements respecting it.

The vein matter shows everywhere heavy quartz with much brown ore, but some of this latter is evidently derived from the alteration of carbonate of iron, which is abundant.

The copper sulphurets were separated very clean by cobbing and dressing, and very few copper minerals can now be seen, but quartz, carrying iron pyrite in small quantity is abundant in every dump.

Some tentative assays show from $3 to $10 per ton in the ore, which would be sufficiently auriferous to allow profitable milling and concentrating. It is estimated that there are 25,000 tons of ore on the dump at present, which can be handled at a merely nominal expense.

The North State (or McCullough) Mine is situated 2 miles west of south from Jamestown. Its southerly extension is the

Lindsay, and its northern the Jacks Hill; then the lode passes on to the unprospected Whitehead property for half a mile or so; and to the north of this is the Aberdeen mine. The entire series forms a stretch nearly 3 miles in length. For a considerable part of this distance the dumps show an immense accumulation of heavy blocks of quartz, which bear witness to the great size of the veins.

The Deep River mine is two miles south of the Lindsay.

The following, in reference to the North State mine, is from Emmons:[1]

"The vein fissure pursues a northeast course, but is curved in the middle. It dips S. 80° E., and at one place S. E. The vein is composed of a column of brown ore resting on the footwall, which extends from the outcrop to 130 feet in depth. Upon this rests the disintegrated ore, containing 8 inches of beautiful copper pyrites, and then against the hanging wall, quartz rather poor in gold and frequently 8 feet thick. The vein at the surface is about 2 feet wide; at 60 feet it is 4; at 90 feet it is 10; and at 130 feet it is 24½ feet wide. It dips at an angle of 45 degrees. At the 130 foot level it swells out into a rather lenticular form. Here the ore is concretionary; on the footwall the brown ore is 6 inches thick only, then copper pyrites, then a belt of brown ore containg nodules or concretions of pyrite more or less changed, the middle of which is rich in gold. Upon the hanging wall is the principal mass of porous quartz, which is generally poor. The brown ore is soft, and easily crushed. It is intermixed with fine quartz and spongy masses of it, which are rich in gold. * * * Towards the north is Jacks Hill; a shaft sunk in the top of this hill cuts the vein at a depth of seventy-seven feet, where it is seventeen feet thick. * * * The copper is the purest sulphuret, yielding by analysis thirty per cent. of copper. * * * The McCulloch vein carries its gold in combination with the sulphurets."

Later information shows that the Rodman shaft was sunk 200 feet vertical, and 50 feet on the underlay; the Eudy shaft is 240

[1] Geological Report of the Midland Counties of North Carolina, 1856. p. 170.

feet vertical and 120 feet on the underlay; the Peters and the Long shafts are of comparatively moderate depth. The last work was done at the depth of 325 feet, where the vein varied from 4 to 8 feet in width. In 1883 a ten stamp mill was erected, and during that and the following year materials from the old mine dumps were treated. In 1885 the mine was abandoned.

At the Lindsay Mine (see also page 115) the more important work was done at the South shaft No. 2, which was 100 feet in depth; twenty-two feet behind the main vein in this shaft a second vein was discovered, but never stoped. Subsequently there were sunk the South shaft No. 1, 90 feet deep; the Engine shaft, 150 feet vertical and 60 feet on the incline; and the Willow shaft, 110 feet deep.

It is not feasible to estimate the amount of ore on the dumps of this stretch of 2 miles or more, still less can any reliable statement of their value be given. Some recent assays indicate a very wide range from $3.00 upwards. A series of 87 assays taken from all parts and from all classes of ore at the Lindsay mine ranged from $4 to $100 per ton.

The Beason, Harland, Beard, Vickery and Lauder, Eudy, and Ball mines are in the immediate vicinity of Jamestown, but no trustworthy information of importance has been secured respecting these.

MINES IN DAVIDSON COUNTY.

The Lalor (or Allen) Mine is situated 2 miles southeast from Thomasville. There are 3 shafts, the deepest of which is 165 feet on the underlay, corresponding to about 140 feet vertical. The vein is reported of good width and carries a fair proportion of iron and copper pyrites. The percentage of copper sulphurets is large enough to give, when concentrated, a product very desirable for matte smelting. The mine was operated in 1882 by the Campbell Mining and Reduction Company of New York. The mill contained 10 stamps and concentrating apparatus. A roasting furnace on a novel plan was erected to desulphurize the ores preparatory to smelting. By 1886 the work had practically ceased.

The Loftin Mine is one and a half miles southeast of Thomasville. Its vein stuff is quite similar to that of the Lalor mine.

The Eureka Mine is one-half mile west of the Lalor. It is penetrated to a depth of 125 feet. The width and character of the vein and the nature of the ore are nearly the same as at the Lalor mine. Assays show the ore to vary from $8.00 to $25.00 per ton.

The Black Mine is adjacent to the Eureka.

MINES IN ROWAN COUNTY.[1]

A group of mines is found to the southwest of Salisbury, from 2 to 9 miles distant, and 1 to 3 miles east of the Southern R. R. Among the principal ones are the Hartman, Yadkin, Negus, Harrison, Hill, Southern Belle, Goodman, Randleman, and Roseman.

The workings in these mines have been comparatively shallow, 160 feet being the deepest so far as records go. The width of the ore bodies and their values are not matters of record, and nothing can be said of them here with exactness.

Another group of mines, including the New Discovery, Dunns Mt., Reimer and Bullion, is situated from 3 to 7 miles east and southeast of Salisbury.

The New Discovery Mine is 3 miles east of Salisbury. The greatest depth to which it has been worked is 100 feet. In 1883 a plant for treating the ore by the Designolle process was erected, but the ore was found deficient in quantity and difficult to treat, and all operations ceased towards the close of the year.

The Dunns Mt. Mine is situated 3½ miles east of Salisbury, and about ⅓ mile northwest of Dunns Mt. It has practically been idle for the past 10 years. The old mine dumps show large masses of a dark grey dioritic rock, impregnated with pyrites; also a fine-grained schistose and a micaceous phase of the same; also a light pink gneissoid granite. The actual relations of these rocks unfortunately could not be ascertained, but it seems probable that the country rock is the gneissoid granite of the Dunns Mt.

[1]For description of mines in Rowan county in the slate belt, see pp. 85-91.

type, which has been penetrated by a dioritic boss or dike, presenting various phases, and carrying the auriferous quartz veins.

It is stated that there are 3 veins, one northeast and southwest, one northwest and southeast, and one nearly north and south (the Office vein). The first of these was worked to a depth of 190 feet, averaging about 4 feet in width. It was largely filled with slate and quartz, and carried only a moderate proportion of pyrite with a trace of chalcopyrite. The Office vein was worked to a vertical depth of about 140 feet. The ores were oxidized nearly to the lowest level, and contained but a small amount of sulphurets.

The Reimer Mine[1] is situated 6 miles southeast of Salisbury, and about 1 mile east of the Gold Hill R. R., on the waters of the Yadkin river. The accompanying cut (fig. 9) illustrates a vertical section of the mine, on the strike of the vein:

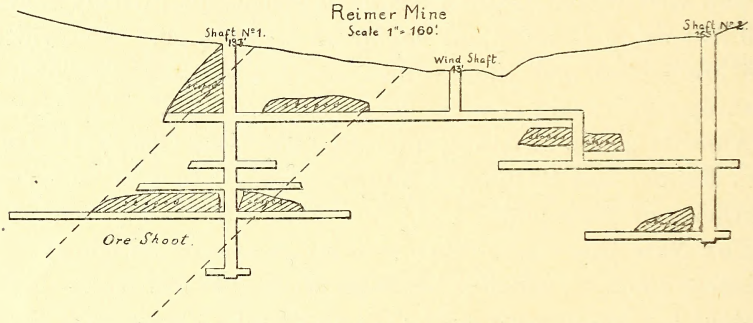


Fig. 9. Showing vertical Section of the Reimer Mine.

The mine is opened by 3 vertical shafts, respectively 193, 43 and 165 feet in depth. The vein-stone is quartz, carrying about 10 per cent of sulphurets (mostly pyrite with very little chalcopyrite), as reported by the superintendent. In width the fissure is stated to average about 3½ feet, varying from 1 to 9 feet. The quartz shows a tendency towards banded structure parallel to the walls, which are smooth and accompanied by a clay gouge.

The strike of the vein is approximately east and west (W. 15° N.), but in the west end of the mine the course has been deflected, by a horse, to about W. 40° N. The dip is practically vertical.

[1]Geological Report of the Midland Counties of North Carolina, 1856. E. Emmons. p. 181.

The following sections (fig. 10) are introduced here in order to illustrate the character and relation of the wall rocks :

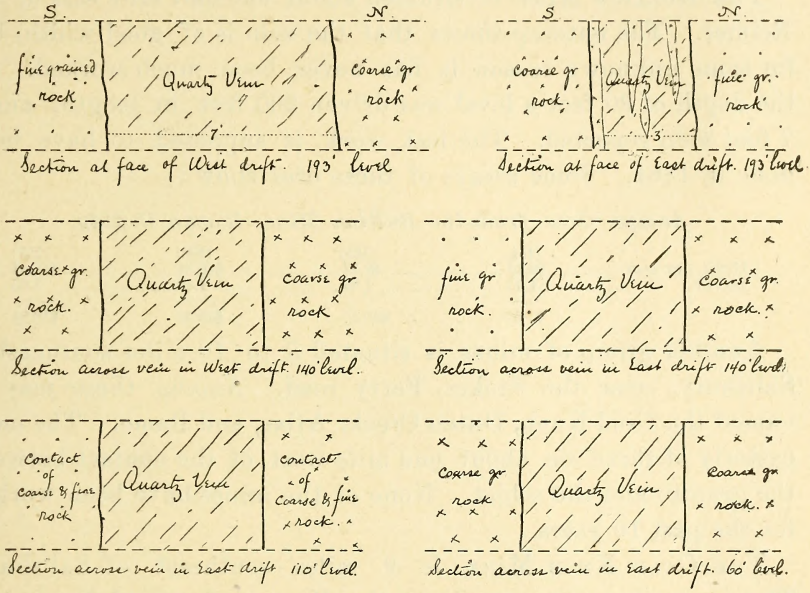


Fig. 10. Cross sections on the Reimer vein in Shaft No. 1, showing character of the wall rocks.

The coarse grained rock is provisionally called quartz diorite, and the fine grained rock is possibly a phase of the same. The alternate occurrence of these two varieties on opposite walls, and even in contact on the same wall (110 foot level) suggests either an intrusive dike of the fine grained rock, or merely a different magmatic phase of the same general igneous mass. The intrusive theory seems rather untenable from the fact that this rock never cuts off the quartz vein.

The last work at the Reimer was done in the summer of 1895, in the lower level of shaft No. 1. In the west drift at a short distance from the shaft a "horse" from the hanging wall had narrowed the vein to 12 inches. The reduction plant at the mine consists of a 20 stamp mill, 4 belt concentrators, roasting furnace, and a one-barrel chlorination house after the Thies pattern. Assays of the ore show as much as $24.00 to the ton, but it is not believed that it can average much over $4.00 or $5.00.

The concentrates are stated to be worth $30 to $40 per ton. About $\frac{1}{5}$ of the gold extracted is saved by amalgamation in the mill.

The Bullion Mine is situated about one half mile east of the Reimer. The outcrop shows that the vein is of good width, but for some unknown reason it has never been much worked. At the depth of 90 feet a level was driven 200 feet in length, and a 7 foot vein reported. The last work is supposed to have been done in 1881. Some assays of these ores show :

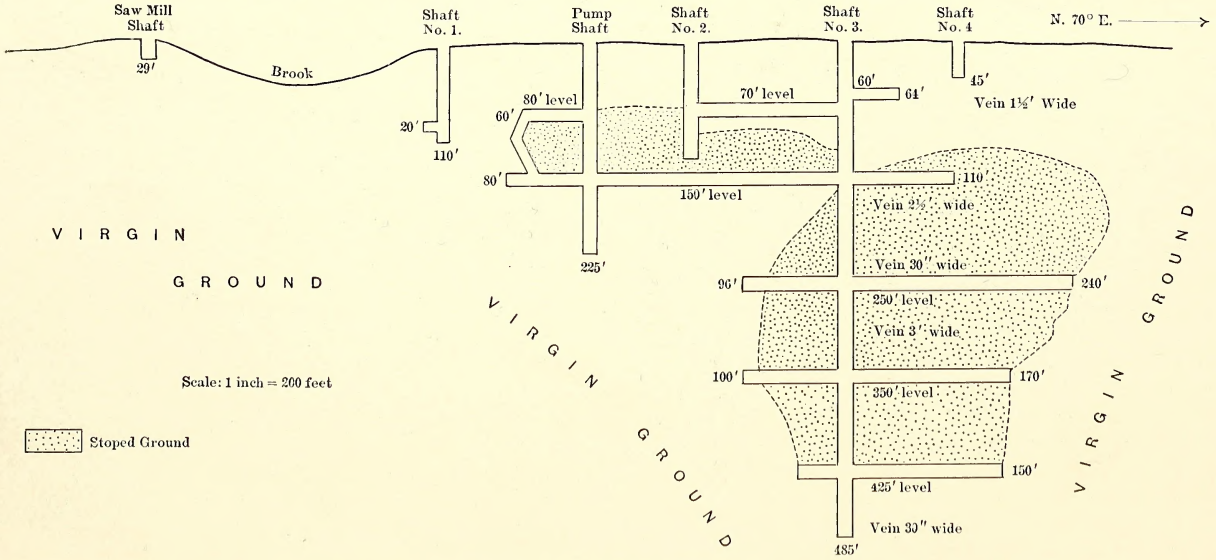
Assays, Ores from the Bullion Mine, Rowan County.

	(154)	(155)	(156)	(157)
Gold, per ton	$6.20	$9.32	$10.34	$15.51
Silver, "	1.30	1 55	1.88	1.03
	$7.50	$10.87	$12.22	$16.54

Another group of mines is situated 8 to 10 miles southeast of Salisbury, near the Stokes Ferry road. Among these may be named the Gold Knob, Dutch Creek, Atlas, and Bame. The more easterly of these lie about one mile west of the contact between the granite and the schist. None of the mines have been worked for the past 10 years.

The Gold Knob Mine is 9 miles southeast of Salisbury. Three veins have been worked : the Haynes, the Gold Knob, and Holtshauser. The Gold Knob is in places 20 feet in width. The quartz carries iron and copper sulphurets, and is, as a rule, of low grade, though chimnies of high grade ore may be expected.

The Dutch Creek Mine is 10 miles southeast of Salisbury, just to the southeast of Dutch Second creek. The property contains a net work of veins, among which the more prominent and chiefly developed ones are the Katie, Hill, Tip-top, and Spring. The Hill and Tip-top have 2 shafts down to water level, below which line the ores are sulphuretted and refractory to mill treatment. Several shafts on the Spring vein also expose sulphurets (pyrite with some chalcopyrite) at water level. Two shafts were sunk on the Katie vein with like results. Several of the other veins are high in copper sulphurets. Most of these veins run in a general northeast and southwest direction, but some seem to have a more northerly course, intersecting the normal running veins.



PHŒNIX VEIN—PHŒNIX MINE.

A longitudinal section from surveys by A. Thies. Shaft No. 2 is vertical; all other shafts are inclined at an angle of about 80 degrees.

Statements made by Mr. Wm. H. Orchard, superintendent of the mine prior to Mr. Thies' connection with it, indicate that the following areas may have been stoped also:—(1) The entire area between Shafts No. 1 and No. 3, above the 150 foot level; (2) between Shafts Nos. 3 and 4, above the 60 foot level; (3) between the Pump Shaft and Shaft No. 3, for a short distance below the 150 foot level; (4) for a short distance below the surface, between the Saw Mill Shaft and Shaft No. 1. But these old workings were inaccessible at the time Mr. Thies' work was done.

The Atlas and Bame Mines are supposed to be in the southwest continuation of the Dutch Creek veins. The strike of the veins is N. 35° to 40° E., with nearly vertical dip. Some of them are wide, but the ore, as a rule, is rather low in grade, at least so far as the free milling qualities go.

CABARRUS COUNTY.

The Joel Reed and Montgomery mines are situated in close proximity to Concord, the county seat, but not enough is known of these to justify any description.

A group of some importance, comprising the Phœnix, Tucker and Quaker City mines, is situated 6 to 8 miles southeast of Concord.

The Phœnix Mine[1] is 7 miles south of east of Concord. It was last worked in 1889 under the management of Mr. A. Thies, E. M., now of the Haile mine, S. C., who treated the ores successfully by the chlorination process. It was inaccessible when visited in 1894. The country rocks are schists, but as the auriferous veins occur in diabase which traverses the schists, the mine is included here in the igneous belt. The old dumps show both soft and silicified types of the schist, besides large masses of diabase of two types: (1) a fine grained, massive; (2) a porphyritic phase of the first. The following notes are based upon data which have been kindly furnished by Mr. Thies:

There are three parallel veins about 200 and 1,000 feet apart. The main (Phœnix) vein, lying on the northwest, strikes N. 70° E., and dips 80° N. W. It has been traced for 2,100 feet on the surface and varies from 12 inches to 3 feet in thickness. Mr. Thies' work was confined to the 300 foot shoot in this vein. It pitches to the northeast, and is opened by shaft No. 3, sunk 485 feet on the dip of the vein. Stoping has been done from the 100 to the 425 foot level. Plate No. IX shows a longitudinal vertical section of the workings. The filling of the fissure is quartz, carrying from 3 to 60 per cent. of sulphurets (pyrite, chalcopyrite and traces of galena). The other gangue minerals are barite, with

[1]Geological Report of the Midland Counties of North Carolina. E. Emmons, 1856. p. 178.

some calcite and siderite. Free gold is found in the barite and calcite. In the bottom of the 485 foot shaft the vein averaged 30 inches in width, but the "pay-streak," lying on the hanging, is only from 2 to 3 inches thick. It is believed that if the vein were drifted on here, in a southwest direction, the large ore shoot formerly mined from the pump shaft, would again be reached.

The Pump shaft, 213 feet deep, is situated 300 feet southwest from No. 3. The so-called "Big Sulphur" shoot was worked here in former years from the 180 foot level to the surface. The ore in the bottom of the shaft is 14 inches thick and shows free gold.

The Phœnix ores were treated by mill amalgamation and subsequent chlorination of the roasted concentrates. A Mears chlorination plant was erected in 1880, and was later on developed by Mr. Thies into what is now generally known as the "Thies process."

The ores were cobbed and sorted, the heavy sulphurets being treated by themselves, and the other portion being milled and concentrated. The mill yield was $10 00 per ton, and about $7.50 was contained in the sulphurets and not free to amalgamate. The concentrates ran $30.00 per ton. The ores contain from 1½ to 3 per cent. of copper. The exstraction of gold by chlorination was as high as 90 to 95 per cent. The mill and chlorination plants are now dismantled.

The "Middle" vein, lying 200 feet southeast of the "Phœnix," was formerly worked by open pitting; towards the northeast it appears to approach the Phœnix. Masses of sulphurets were found here, assaying as high as $36.00 per ton.

About 1,000 feet to the southeast of the Middle vein is a heavy sulphuretted lode, composed mainly of chalcopyrite in a gangue of quartz and barite. The old workings, which were shallow, are now inaccessible. Assays of the surface ore show 22 per cent. copper and $42.00 gold and silver per ton.

The Barrier Mine is 1 mile southwest from the Phœnix, on the same property, and was formerly open to a depth of 160 feet. It is stated (by Mr. Orchard) that there are two veins here, 12 feet apart, the one 14 inches thick and perpendicular, and the other 16

inches thick and inclined; at 160 feet they are only 2 feet apart. The ore is reported to have been worth $3.00 a bushel ($60.00 a ton. This mine was last worked, previous to 1860, by Mr. Orchard (deceased), and has not been operated since.

Adjoining the Phœnix on the northeast and west boundaries are the *Furness* and the *Gibb mines*, which were worked in former years, and are reported to have yielded high grade sulphuretted ores. A shaft has recently been sunk on the Furness property, but the results of the exploration are not known.

The Faggart Mine is 3 miles northeast of the Phœnix. It was opened by a shaft 100 feet deep, with a drift probably 50 feet in length. The vein is 18 inches wide, and composed of auriferous quartz and pyrite, having a stated value of $7.00 per ton.

The Barnhardt Mine[1] is 1½ miles east of the Faggart. The quartz vein, carrying galena and chalcopyrite, lies in diorite or diabase. It is reported to be 5 feet in width; with a value of $9.00 per ton, in gold. A small stream on the property was worked for years, and has furnished very coarse gold, up to 5 and 6 pennyweight pieces.

The Tucker (or California) Mine is about 1 mile south of the Phœnix, and about one-third mile west of the junction of the granite and the schists. When last worked (about 1884) the main shaft had reached a depth of about 175 feet, and levels aggregating 117 feet in length had been driven. The vein did not average over 8 inches wide, with northeast strike and nearly vertical dip. The ore was heavy in sulphurets (mostly pyrite with a little chalcopyrite) in a gangue of quartz and barite. Its value is stated to have been $15 per ton. In 1882 a Plattner chlorination plant was erected, with one single hearth reverberatory furnace, but it did not give satisfactory results, and the Mears process was introduced.

The Quaker City Mine is 3 miles north of the Tucker. There are 3 shafts on the property, 40, 60, and 80 feet deep, respectively. The vein is from 2 to 5 feet wide, and carries in its lower depths much iron pyrites with a little copper. The ore is low grade. It has not been operated during the past 10 years.

[1]Geological Report of the Midland Counties of North Carolina, 1856. E. Emmons. p. 178.

The Reed Mine[1] is situated 10 miles southeast of Concord. It is of especial interest as being the site of the earliest recorded discovery of gold in North Carolina, and it was the first mine to give celebrity to the gold fields of the Appalachian range, though probably not the first to yield gold.

In 1799 the first nugget, weighing 17 pounds, was accidentally found in a branch; and this was followed in 1803 by the discovery of a 28 pound nugget, the largest on record in the Eastern United States. Regular mining work was commenced shortly after this latter date, and during the subsequent period of 40 years, the mine yielded large quantities of gold. The proportion of large nuggets has not been paralleled on this side of the continent. Notwithstanding the fact that the gravel has been so long worked, there are some hollows or sinks of several acres in extent, which are almost virgin, but as the drainage is very imperfect they have never received the attention they deserve. The immediate supply of water is not large, but Rocky river and Buffalo creek might be tapped for the requisite supply for large hydraulic operations.

The mine might perhaps more properly be said to be in the Carolina Slate Belt, but the auriferous veins are confined to a large greenstone dike (reported to be 150 feet in width), and therefore it is placed here in the Igneous Belt. This greenstone is impregnated with pyrite, and contains quartz fissure veins, varying from 4 inches to 3 feet in thickness, and striking about N. 25° E., with a dip of 45° to 57° S. E. Cross fissures also occur. The main shaft is 120 feet deep. It was inaccessible in 1894. The mine was operated in a fitful manner from 1881 to 1887. During 1895 some prospecting and development work has been done; the old shaft on the "lower hill" has been opened up and retimbered; the west side of the "upper hill," the west and south sides of the "lower hill," and both banks of Little Meadow creek have been opened up for placer work; and a shaft has been sunk near the western limit of the property which has opened up a large body of low grade ore that is said to assay $7.50 per ton in free gold, and $11.55 per ton of gold the sulphurets. Preparations are being made for active mining.

[1]Geol. Report of the Midland Counties of North Carolina, 1856, E. Emmons, pp. 166-167.

THE PIONEER MILLS MINE[1] is situated 12½ miles south of Concord, on the waters of Caldwell creek, which flow into Rocky river. The mine has not been operated practically since the late war.

Only one exposure of the country rock rock was observed in place; it is a much decomposed granite. The old mine dumps show vast masses of a gabbroitic eruptive rock of various crystalline phases, from coarse to fine granular, and with alterations to a propyllitic type. A fine crystalline diabase, in part porphyritic, also occurs, and contains small quartz veinlets. A large specimen was found showing a sharp contact between the coarse crystalline gabbro (?) and the fine grained diabase. A very fine crystalline granite was also observed, which is perhaps a dike formation in the gabbro (?). The ore is quartz, containing iron and copper sulphurets, which sometimes show excellent banding, an example of incrustation. Siderite is one of the gangue minerals.

Other mines in this vicinity are the Morrison, Crosby (or Poplan), and Rogers, none of which are now accessible.

MECKLENBURG COUNTY.

Gold is probably more widely diffused in Mecklenburg than in any other county of the central part of the State. The productive area covers about 600 square miles, within which are well nigh 100 mines, which have at some time or other been worked profitably. About half a dozen of these mines are now worked, but only 2 or 3 with any vigor. The great number of these localities forbids a full description of each. Only those at work, or those which are considered the more important, can be described in the limited space of this report.

To a great extent they are capable of being grouped into smaller districts. The vicinity of Charlotte is one of these mineral districts, and around it are mines on all sides, among them the following: Davidson, Blake, Point, Parks, Clark, St. Catherine, Rudisil, Smith and Palmer, McDonald, F. Wilson, Howell, Trotter, Carson, Taylor, Isenhour, and others unknown to the general public, and unnamed.

[1] Geological Report of the Midland Counties of North Carolina. 1856. E. Emmons, p. 178.

THE DAVIDSON MINE is 1 mile west of Charlotte, on the south end of Davidson Hill. It has been worked to a depth of 80 feet; the vein was 3 to 4 feet wide, and the ores were reputed good.

The Point Mine, at the north end of Davidson Hill, was worked to a depth of 160 feet. The oxidized ores extended much deeper than is usual in this region.

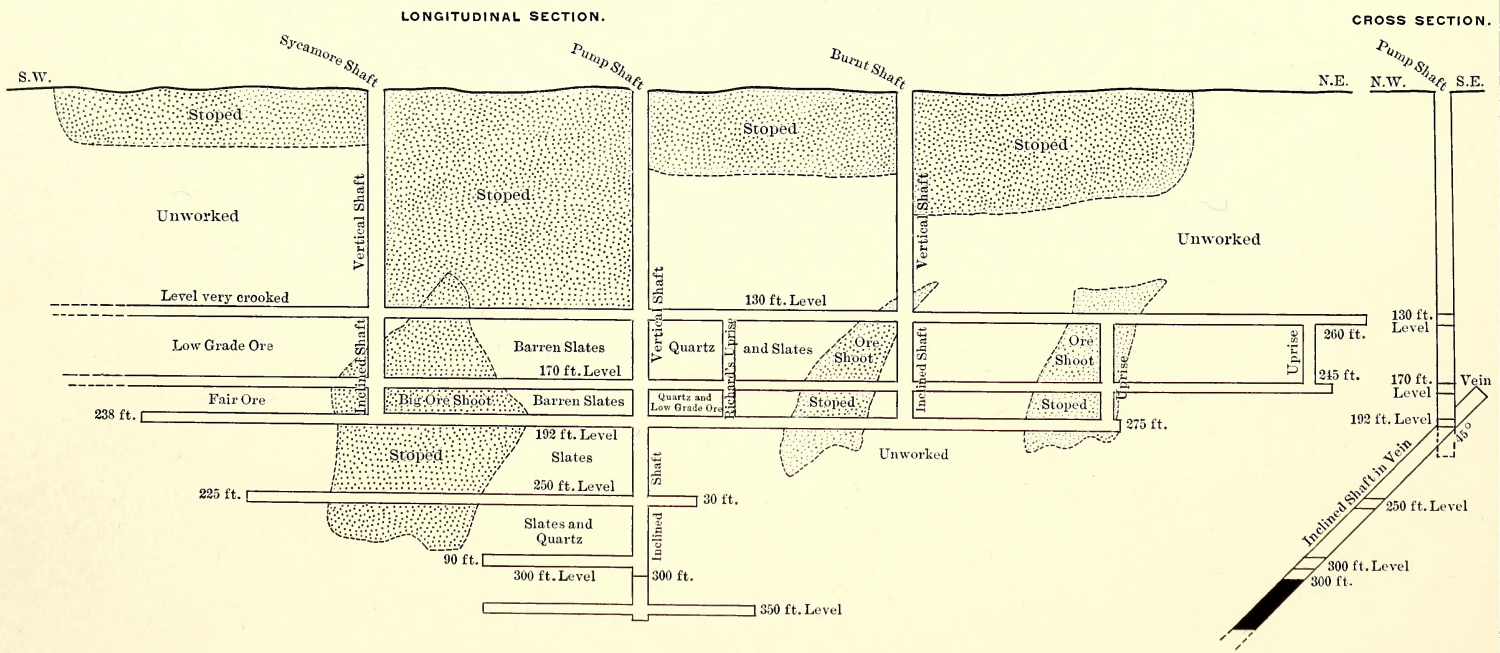
THE RUDISIL MINE[1].—The Rudisil and the St. Catherine mines are respectively in the south and the north parts of the same lode; the former is one mile, and the latter one-half mile south of Charlotte.

The bodies of ores in both mines nearer the surface lie in slates, which in places approximate 100 feet in width. These slates are both argillaceous and chloritic, everywhere siliceous, and frequently replaced by layers of quartz with ore. They are bounded by the country rock of the igneous belt, massive crystalline rocks.

At the outset, and to the depth of something more than 100 feet, two bodies of ore were recognized—the "back vein," and the "front vein," but the intervening mass of slate frequently carried subordinate bodies. Emmons[2] says of the Rudisil mine: "The rock both above and below the two veins, which constitute the mine, is the syenitic granite of the Salisbury and Greensboro belt; but the veins are immediately in killas or slate, which cannot be distinguished from the slates which predominate in the slate belt; and there are other points where the slate is in granite, and not less than 100 feet thick, which is traversed with veins of quartz. It is difficult to determine whether the slate thus situated is to be regarded as the killas of the vein, or as masses of the slate system isolated by an eruptive rock."

"Thus the Rudisil veins are between masses of an eruptive rock. * * * * The vein fissure is fifty feet thick, occupied by talcose slate, which is overlaid by white granite, and underlaid by elvan or a dark trappean rock. A vertical section, Fig. 11,

[1] Geol. Report of the Midland Counties of North Carolina. E. Emmons, 1856. pp. 176-177.
[2] Idem.



RUDISIL MINE.

Vertical (in part) longitudinal and cross sections, drawn from the notes of Wm. Jenkins and Wm. I. Smart, 1883. Scale: 1 inch=110 feet. The black color in the lower portion of the cross section indicates the unworked portion of the vein.

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shows the position of the two veins, lying one (b') against the elvan (a'), and the other (b) against the white granite (a)."

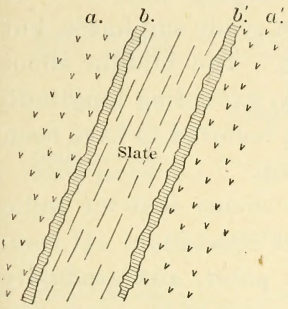


Fig. 11. Ideal vertical section across the Rudisil fissure.

The strike of the fissure approximates N. 30° E., and the dip 45° N. W. At the depth of 200 feet or more the slaty character becomes less evident, and ultimately disappears, seemingly giving place to the massive country.

The two ore bodies (front and back veins) vary considerably in width from 2 to 4, and sometimes 6 feet. At the depth of 200 feet they appear to approach.

The ore was carried in pockets in the slates (or schists), and in great abundance, so that for many years the mine was very prosperous. At the surface, and to a considerable depth, the mine material was the rich and easily treated brown ore of the region.

The zone below water level carried iron pyrite with a little copper pyrite; and the ore was scattered somewhat through a slaty and quartzose gangue, being less pockety than that above the water line. The assays for this zone as a rule showed material of only moderate value. At the 200 foot level the peroxides have mostly disappeared, and with them largely the free gold, though both are present in some proportion to the lowest level—350 feet below the surface. (See plate No. X.)

At greater depths the sulphurets were scattered thinly through a quartzose and somewhat slaty gangue, or in narrow seams, or concentrated in large, wide and rich shoots of nearly solid sulphurets. An inspection of the plate will show the position of these shoots—3 in number. As regards the northern shoot neither the point of origin nor its character are matters of record; it is not known above the 130 foot level.

The south and the middle ("Burnt Shaft") shoots began just above the 130 foot level in narrow threads, and expanded both in width and in length at greater depths. Neither the north nor the middle shoots have been followed below the 192 foot level to any extent, though slightly explored from the 250 foot level. The

north shoot increased from a mere seam to 5 feet in thickness, and had a length in the direction of the vein, varying from 30 to 50 feet. The material of this shoot was a high grade sulphuret, but not the best that the mine has furnished. The middle shoot increased in the same way to be 8 feet thick, extending longitudinally from 10 to 50 feet; the grade of ore is believed to have been somewhat higher than that of the north shoot.

It was, however, to the Big shoot (South shoot) that the mine has in recent years (as late as 1887) owed its reputation. It commenced like the middle shoot almost in a point, and gradually widened and lengthened with a slight south pitch of its own in the vein, till it became in places 15 feet thick, and 100 feet long; its ends were not abruptly marked off from the adjacent vein or from the "country," but passed gradually into mine material comparatively barren, or into "country" quite worthless.

The contents of the shoots, as a whole, were compact iron pyrite with a very little copper pyrite, and some quartz, which latter was, however, for the most part readily cobbed out. This ore was uniformly of high grade, entire shipments sometimes ranging as high as $180 per ton.

This shoot extended down a little below the 300 foot level, but in the 350 foot level it has never been found. There has been much speculation about it, and opinions have varied as to whether it had disappeared altogether, or was simply "thrown" from its normal position by one of the many deflections of the vein from its direct course.

It may be added in conclusion that the so-called barren parts of the vein carry pyrites scattered through the quartz and slate, and most of it is quite capable of being treated by a preliminary cobbing to separate the massive pyrites for direct metallurgical treatment, and at the same time prepare the lowest grade material for battery amalgamation and subsequent concentration preparatory to smelting or chlorination.

The following assays show the character of some material from this mine:

Assays, Ores and Concentrates, Rudisil Mine, Mecklenburg County.

Assays of Auriferous Pyrite scattered in gangue.

	(158)	(159)	(160)	(161)
Gold, per ton	$ 6.20	$ 9.30	$12.40	$20.67
Silver, per ton	trace	2.49	trace	.13
	$ 6.20	$11.79	$12.40	$20.80

Assays of First Class Ore, Rudisil Mine.

	(162)	(163)	(164)
Gold, per ton	$ 45.47	$ 72.35	$ 74.41
Silver per ton	trace	trace	trace
	$ 45.47	$ 72.35	$ 74.41

Assays of Second Class Ore, Rudisil Mine.

	(165)	(166)	(167)	(168)	(169)	(170)	(171)
Gold, per ton	$24 80	$28 70	$29.97	$31 01	$35.14	$35.14	$36.18
Silver, per ton	trace.	trace.	.19	trace.	.65	.96	.13
	$ 24.80	$27.70	$30.16	$31.01	$35.79	$36.10	$36.31

Assays of First Class Cobbed Sulphurets, Rudisil Mine.

	(172)	(173)	(174)
Gold, per ton	$165.36	$126.09	$227.37
Silver, per ton	.45	.94	1.71
	$165.81	$127.03	$229.08

Assays of Concentrates, Rudisil Mine.

	(175)	(176)	(177)
Gold, per ton	$53.74	$59.94	$67.18
Silver, per ton	2.90	1 73	1.14
	$ 56.64	$61.67	$68.32

The St. Catherine (Charlotte) Mine is located in the northeast extension of the Rudisil lode (page 126), the two mines being over half a mile apart. The region intervening has been prospected superficially, but as yet nothing of importance has been found which promised well for deeper operations. Both mines have the same general features, and agree in strike and dip.

The St. Catherine has been worked to a depth of 460 feet (155 feet vertical and 305 feet on the underlay, equivalent to a total vertical depth of 370 feet).

In the lower part of the mine the vein does not seem to be well consolidated, and the geological relations are perplexing. Below 250 feet there are several large shoots of low grade ore quite suitable for milling and concentrating, notably the ore body worked from the "pump" shaft and between the depths of 200 and 370 feet, below which point it has not yet been removed. The occurrence may be briefly stated as a series of obscurely parallel seams of slate, with quartzose ore bodies 2 to 6 feet in

thickness between; the amount of pyrite in this class of ore is small.

A cross vein (striking N. W. and S. E.) has been examined from the 155 foot level for a distance of 100 feet along the vein.

The following assays show the range in character and value of some of the ores of this mine:

Assays, Gold Ores, St. Catherine Mine, Mecklenburg County.

Assays of Brown Ores.

	(178)	(179)	(180)	(181)
Gold per ton	$ 26.87	$ 39.27	$ 56.87	$103.35
Silver " "	.71	.58	.38	.88
	$ 27.58	$ 39.85	$ 57.27	$104.23

Assay of Quartz, with Dissemminated Pyrite, St. Catherine Mine.

	(182)
Gold, per ton	$24.80
Silver, "	.16
	$24.96

Assays of First Class Ores, St. Catherine Mine.

	(183)	(184)	(185)
Gold, per ton	$ 52.19	$ 53.74	$ 72.41
Silver, "	.55	trace	.39
	$ 52.74	$ 53.74	$ 72.80

Assays of Second Class Ores, St. Catherine Mine.

	(186)	(187)	(188)
Gold, per ton	$ 35.14	$ 33.07	$ 35.14
Silver " "	1.14	trace	.28
	$ 36.28	$ 33.07	$ 35.42

Assays of Cobbed First Class Ore, St. Catherine M2ne.

	(189)	(190)	(191)
Gold, per ton	$95.08	$108.52	$181.38
Silver, "	.41	trace	trace
	$95.49	$108.52	$181.38

Assays of Concentrates, St. Catherine Mine.

	(192)	(193)	(194)
Gold, per ton	$40.31	$ 66.14	$133.32
Silver, "	1.10	1.23	1.23
	$41.41	$67.37	$134.55

In 1883 a ten stamp mill was erected. The ores were first subjected to a preliminary cobbing, which separated out the massive pyrites and lean ore, the latter going to the stamp mill. The free gold was caught in the battery and on the plates in the customary mode of amalgamation, and the tailings led directly to Frue vanners, where the product was concentrates. The cobbed pyrites and concentrates were shipped north and elsewhere for treatment.

The proportion of massive pyrites to the whole material mined (except when near a rich chimney) was small, probably not more than 2 or 3 per cent.

In the common run of mining and milling practice it required 10 to 15 tons of ordinary ore to make one ton of concentrates, which ordinarily contained 80 to 90 per cent. sulphurets. It is worthy of remark that the concentrates, however high the per cent. of sulphurets, rarely contained as much gold per ton as cobbed ore of the same richness in sulphurets.

The last work at the St. Catherine, of which the writer is aware, was in 1887.

The Smith and Palmer Mine is 1 mile south of Charlotte, in the Rudisil neighborhood. It is a mooted point whether the vein be an extension of the Rudisil, or a parallel body. Its strike is N. 30° E. and dip 50° N. W. A line of pits indicate vein matter for something more than 500 feet along the strike. The greatest depth of the workings was 75 feet, and the width of the vein from 2 to 4 feet. Assays of some samples show:

Assays, Gold Ore, Smith and Palmer Mine, Mecklenburg County.

	(195)	(196)	(197)	(198)	(199)
Gold, per ton	$ 5.17	$ 5.17	$ 15.51	$ 15.51	$ 148.82
Silver, per ton	trace	.39	trace	.26	.91
	$ 5.17	$ 5.46	$ 15.51	$ 15.77	$ 149.73

Two other veins in the neighborhood deserve mention in this connection, namely, the Frank Wilson and the McDonald. The former has hardly been touched; the latter has been worked to a moderate depth, but no record of the work has been preserved.

The Howell Mine is believed to lie in the southern extension of the Rudisil lode. It has been worked to a depth of 32 feet, and something more than 50 feet of levels have been driven. The vein is stated to be 2 to 4 feet wide. Assays of the brown ores show $5 to $14 per ton, and of the sulphurets $38 to $77.

The Taylor Mine is 3 miles southwest of Charlotte, and the *Isenhour* is still further in the same direction. Each of these has been worked for a distance of about 400 feet along the vein, but to a very moderate depth.

The Trotter Mine is 3 miles sonthwest of Charlotte, and its vein is cut by the Southern R. R. (Charlotte & Atlanta line.) It

has been prospected nearly 450 feet in length, and worked 70 feet in depth. Some rich specimens were taken from the mine.

The Clark Mine is 2½ miles west of Charlotte. There appear to be two vein systems, one lying approximately northeast and southwest, and the other nearly east and west. Both have a steep dip southward. The northeast and southwest system was worked to a depth of 70 feet, and from the line of pits the inference is reasonable that it must have been worked along the strike of the vein for a distance of about 1,200 feet. It is alleged that this part of the mine was abandoned on account of flooding by water.

Assays of samples taken from this vein yield the following results:

Assays, Gold Ores, E. and W. Vein, Clark Mine, Mecklenburg County.

	(200)	(201)	(202)
Gold, per ton	$ 5.17	$ 31.01	$ 146.76
Silver, per ton	trace	1.21	.29
	$ 5.17	$ 32 22	$ 147.05

The east and west vein was worked to a depth of 78 feet. In the 72 foot level 3 bodies of low grade brown ore were found within a space of little less than 25 feet; they measured respectively 2 ft., 4 in.; 7 ft., and 7 to 12 in.; the latter body was the only one rich enough to work, and an average sample showed $16 per ton, assay value.

The Parks Mine is 1 mile northeast of Charlotte; no great depth was ever attained in its workings.

A second group of mines is found 5 to 10 miles west and northwest of Charlotte, embracing the Hayes, McGee, Brawley, Frazer, Hipps, Campbell, Todd, Arlington, Capps, McGinn, Means, Bennett, Stephen Wilson, Gibson, Neal, Trautman, Prim, Abernathy, Alexander, Dunn, Sloan, McCorkle, Cathey and several others.

The Brawley Mine is 4 miles west of Charlotte. It has been quite productive, and the quantity of rich float quartz was large, but all efforts to find a vein have proved abortive. The work thus far done would indicate the existence of a net work of quartz seams.

The Todd Mine is situated 5 miles northwest of Charlotte. There are two, and possibly three, veins on the property. The vein which was most extensively worked strikes east and west, and dips 45° southward. It has been penetrated to a depth of 80 feet. Some exploratory work was done at this mine in 1886, and a ten stamp mill erected.

The Arlington Mine is 6 miles west of Charlotte, and has been sunk to a depth of 70 feet.

The Stephen Wilson Mine is 9 miles west of Charlotte. The property comprises 340 acres, and it is stated that 10 well defined veins have been located. Of these only two have been worked, namely, No. 2 and No. 3. Both of these have a strike nearly east and west, and dip southward, No. 2 from 26° to 45°, and No. 3 a little more steeply. No. 2 vein is from 2 to 3 feet wide; it was entered by an underlay shaft to a depth (on the incline) of 400 feet, and 4 levels run. The ores carry iron and copper pyrites. Some very rich ores have been mined. Assays show the following results:

Assays, Gold Ores, Stephen Wilson Mine, Mecklenburg County.

	(203)	(204)	(205)	(206)	(207)	(208)
Gold, per ton	$ 0.83	$ 24.80	$ 51.22	$ 95.08	$155.03	$344 67
Silver, per ton	.26	.90	.88	2.46	1.55	1.29
	$ 1.09	$ 25 70	$ 52.10	$ 97.54	$156.58	$345.96

The Gibson and Neal mines adjoin the Stephen Wilson.

The Capps Mine is situated 5½ miles northwest of Charlotte, between the Rozzel's Ferry and Beattie's Ford roads. It is located on a group of veins of which two are closely convergent (the Jane and the Capps). By the accident of different ownerships, they have been for the most part separately and differently developed. The Capps vein has a strike N. 30° to 35° W., and a dip westerly, with some variations, of about 40°. The Jane vein runs N. 40° to N. 60° E., and has a very steep pitch eastward. It is not certain that the actual intersection of these veins has been found. The Capps vein has an ascertained length of nearly 3,000 feet, and the Jane probably fully as much.

As the development of these two veins has been separate, the description will follow the course of the work.

The accompanying sketch (fig. 12) shows the relative position of the veins, properties, shafts, and worked areas. It shows also the position and relations of the McGinn Copper vein.

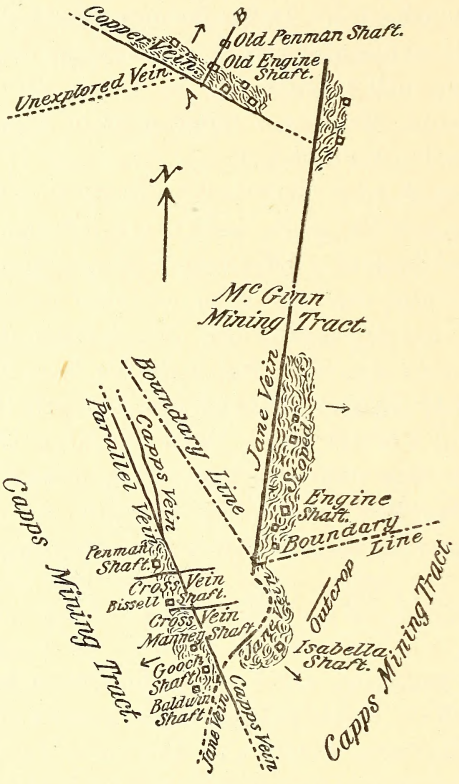


Fig. 12. Capps and McGinn Mining Tracts, Mecklenburg County.
[Scale: 1 inch to 75 rods.]

The later work on the Capps was restricted, and finally stopped, from legal considerations, but the earlier work extended very nearly along the line of the outcrop of the entire vein—2,000 to 3,000 feet—and was carried to such depths as to disclose clearly the character of the outcrop. At points where the ore proved to be exceptionally abundant and valuable, operations were extended much deeper. There is perhaps no vein in the whole section which shows such extensive prospecting on the surface, and bears all the appearance of having been highly remunerative.

It is much to be regretted that there are such scanty records of the earlier work, and of the characteristics of the veins and deposits. The outcrop of the vein at many points still shows a width of 20 to 25 feet, and the debris everywhere indicates a very wide vein.

The ores near the surface are the customary soft brown ores with quartz, and are generally free milling.

They were not uniformly disseminated in the quartz, but generally occurred in layers, sometimes near the hanging wall, sometimes near the foot wall. At greater depths sulphurets of iron (and to a small extent, of copper), together with quartz, were found; nevertheless, at the depth of 130 feet there was still much brown ore.

The work was never prosecuted to any great depth—at the Gooch shaft 70 feet, at the Bissell 130, and at the Penman 65 feet.

The filling of this vein is quartz; its width is not known, for no systematic work has ever been undertaken to find the walls; it cannot be less than 20 feet, and possibly is considerably more.

The line separating the veins from the walls is not always sharp and definite, and occasionally, where the supposed hanging wall had been reached, another and valuable parallel body of ore was found still further beyond, which ultimately came back to the main vein.

There are also "cross courses," leading into the main vein nearly at right angles. One of the most conspicuous and valuable of these was found in the 130 foot level, at the distance of 225 feet southeast of the Bissell, and about one-half way between the Bissell and Mauney shafts. It received temporarily the name of the "East and West vein," for want of exact data as to its relations to the main vein. This body departs abruptly from the main vein easterly and towards the Jane vein, and has been followed in that course 120 feet, and almost every foot of the vein material was ore. The width of this deposit could not have been much less than 18 to 24 inches, and the ore was of more than average value.

A few feet further north there is a similar cross course or body of ore, but so far as explored it was not so valuable as the "East and West vein."

The Capps mine has been noted for the amount of ore it could furnish, and for the superior grade of its ore. There are four well known bodies of ores. The first of these is near the Gooch shaft, toward the south end of the mine, and from the 78 foot level downward it yielded largely brown ore with some sulphurets, and seemed to improve in character going south.

The second body is in the 78 foot level from the Mauney shaft. Not much can be said with precision respecting the value of this ore, though the upper part of the body toward the surface yielded an ore of high grade.

A third and very large ore body was worked out through the Bissell shaft to the depth of 90 feet. The entire length of this level is 300 feet, of which 200 feet are to the north, and 100 feet to the south of the shaft; the whole of this distance was ore, free-milling to a great extent above, but more and more sulphuretted below; it has never yet been entirely extracted above the 90 foot level, but the best part of it has been stoped out. Below the 90 foot level the ore has not been stoped out at all, except as it was necessary to remove it in running the levels. The body has been explored by a few winzes run downward toward the 130 foot level. Its connection with the large body developed in the 130 foot level has not yet been established conclusively, but there seemed to be little doubt from its position and character that there is such a connection. This body in the 130 foot level is found at a point 125 feet south of the Bissell shaft, and extends north as far as the work has been prosecuted. The shoot cannot be less than 200 feet long, and judging from the 90 foot level, it may be 300 feet.

Some assays of the ores from this shoot are as follows:

Assays, Gold Ores, Third Ore Body, Capps Mine, Mecklenburg County.

	(209)	(210)	(211)	(212)	(213)	(214)
Gold, per ton	$ 11.72	$ 15.51	$ 17.92	$ 25.84	$ 49.61	$ 132.29
Silver, per ton	trace	.32	.14	.13	.97	.84
	$ 11.72	$ 15.83	$ 18.06	$ 25.97	$ 50.58	$ 133.13

Assay No. 211 is an average of a large body of ore from this 130-foot (?) level.

A fourth body was found in the bottom of the Penman shaft, 335 feet north of the Bissell. The stopings north of the inclined shaft are very extensive and reach to its bottom; the ore body could not have been less than 3 feet thick on an average, and this increased in one place to be 8 feet; a very little good ore is still to be seen at the bottom.

The deposit in this part of the mine is comparatively shallow, and is, and will continue for some distance, free-milling. The facts recited will justify the expectation of large and valuable bodies of ore at still greater depths.

That part of the Jane vein on the Capps mining tract was worked in part from the Isabella shaft to a depth of 160 feet. There is no record of the value of the ore body at this point; common report speaks well of it, but admits the refractory character of the ore.

The Capps mine was reopened in 1882, and during the following year some ore was shipped to the Designolle works, 4 miles south of Charlotte. However, this process of reduction was unsatisfactory. In 1884 a ten stamp mill was erected at the mine, and the ores from the dump were milled; shortly after that time all operations ceased. In the spring of 1895 four diamond drill holes were bored on the Capps vein, respectively 340, 255, 180 and 170 feet deep. The vein was cut by each hole, and showed a thickness of 20 feet, with a dip of about 30° S. W. The walls were fine and coarse grained diorite, at times porphyritic. Assays of the vein matter from the drill cores gave $6 to $7 per ton.

The McGinn Mine adjoins the Capps on the north. The accompanying sketch map (Fig. 12, p. 134) shows three veins, one of which has never been explored, the second is the Jane,

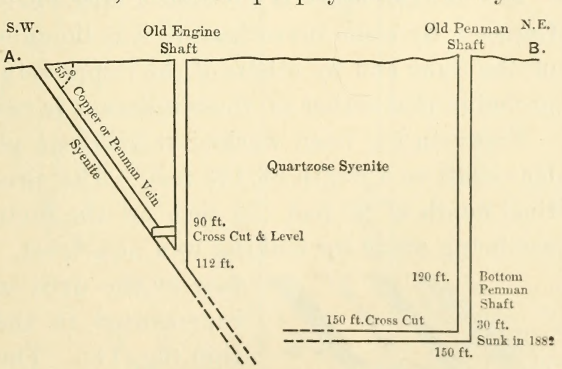


Fig. 13. McGinn Mine, copper vein; a vertical cross-section through the old engine shaft shown in Fig. 5 of Plate XI, and on the line A-B of Fig. 12, page 134.

and the third is the Copper vein. The appearance and relations of these veins and of the ore bodies are shown in the sections on Plate XI, and in figure 13 (p. 137).

The Jane vein has been worked from various points, and especially from the Engine shaft (150 feet), at which point all of the readily accessible ore bodies above the 150 foot level have been extracted. A glance at plate XI will show an ore body not much less than 35 feet wide, at points, and at the same time will disclose in the clearest manner some of the characteristics of the vein structure, common to this and to other mines.

The Copper vein was operated extensively for copper to a depth of 110 feet, i. e. as far down as could readily be done some 50 years ago, with the appliances then at command. The ore was yellow sulphuret, and was shipped from the State for treatment.

The following assays are appended:

Assays, Gold Ores, Jane Vein, McGinn Mine, Mecklenburg County.

	(215)	(216)	(217)	(218)	(219)	(220)	(221)
Gold, per ton	$ 2.07	$ 5.17	$ 23.25	$ 28.42	$ 99.22	$108.52	$113.68
Silver, per ton	1.20	1.74	.31	.31	.71	1.65	.77
	$ 3.27	$ 6.91	$ 23.56	$ 28.73	$ 99.93	$110.17	$114.45
Copper, per cent		8.05%				4.55%	

Assays, Ores from Copper Vein, McGinn Mine, Mecklenburg County.

	(222)	(223)	(224)
Gold, per ton	$ 5.17	$ 10.85	$ 12.40
Silver, per ton	1.74	1.65	1.20
	$ 6.91	$ 12.50	$ 13.60
Copper, per cent	7.50%	4.55%	8.05%

The Means Mine is situated ½ mile nearly southeast from the Capps. By some investigators it is thought to be a continuation of the Jane and by others of the Capps vein, but it scarcely seems probable that either of these opinions is correct.

The vein has been worked at different points, and in the Wallace shaft to a depth of 175 feet. The present work is at a vertical depth of 25 feet (36 feet on the incline), but preparations are being made for sinking to a new level. The exposure at the face of the drift on the 25 foot level is represented in the accompanying section (fig. 14). The strike at this point is N. 35°–40° E. The ores carry much

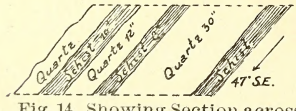
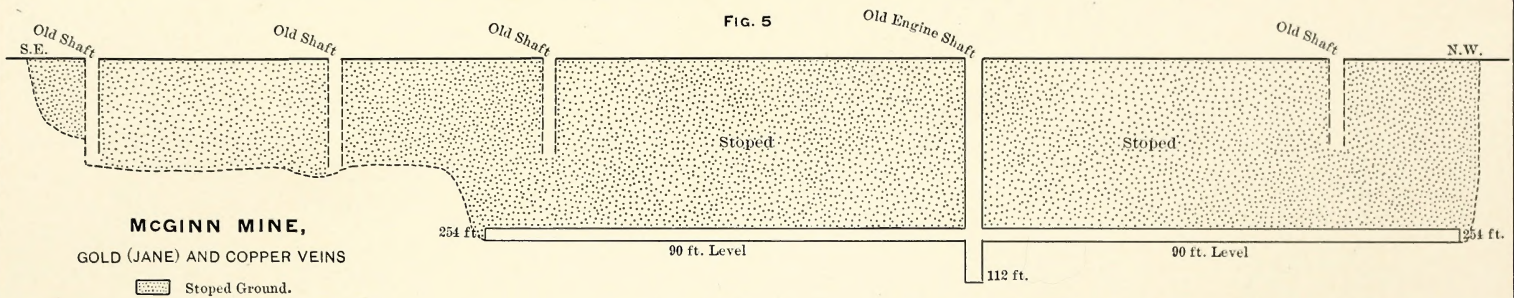


Fig. 14. Showing Section across Ore body in Means Mine.

FIG. 5



McGINN MINE,

GOLD (JANE) AND COPPER VEINS

Stoped Ground.

FIG. 1

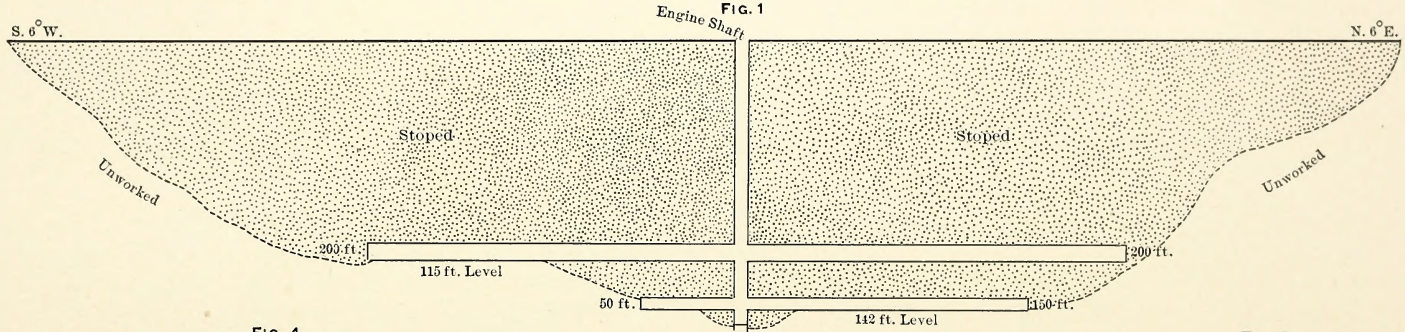


FIG. 4

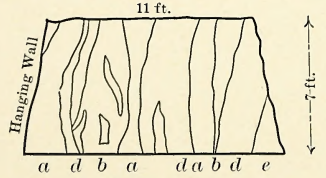


FIG. 2

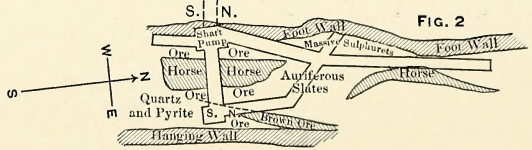
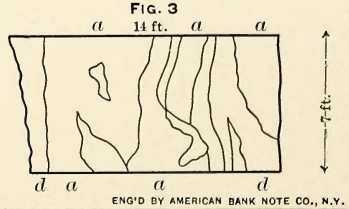


FIG. 3



ENG'D BY AMERICAN BANK NOTE CO., N.Y.

chalcopyrite. The precious metal content is shown by the following assays.

Assays, Ores from the Means Mine, Mecklenburg County.

	(225)	(226)
Gold, per ton	$ 7.02	$ 28.44
Silver, per ton	1.65	1 94
	$ 8.67	$ 30.38

The Hopewell (or Kerns) Mine is 11 miles northwest of Charlotte. It yielded well in former years. The last work was done at the depth of 140 feet. Conflicting statements have been made respecting the amount and value of the ore at this depth. The manager's statement is that at the depth of 80 feet there were two veins aggregating 5 feet in width, and at 140 feet a two foot vein of good yellow copper ore. Some assays of the ore from this mine show:

Assays, Ores from the Hopewell Mine, Mecklenburg County.

	(227)	(228)	(229)
Gold, per ton	$ 4.13	$ 12.40	$ 16.53
Silver, per ton	trace	trace	1.10
	$ 4.13	$ 12.40	$ 17.63
Copper, per cent	18.83%	17.08%	12.23%

The Green C. Cathey Mine, 8 miles northwest of Charlotte, carries copper ores, and has been explored sufficiently to develop an ore body of good grade. Some assays of ore from this mine show:

Assays, Ores from the G. C. Cathey Mine, Mecklenburg County.

	(230)	(231)	(232)
Gold, per ton	$ 8.27	$ 7.23	$ 14 47
Silver, per ton	1.23	3.88	.39
	$ 9.50	$11,11	$ 14.86
Copper, per cent	14.84%	25.40%	

The Sloan mine adjoins the G. C. Cathey, and has been worked to a depth of 40 feet.

The Chapman (or Alexander) Mine is in the same vicinity, near the Rozzel's Ferry road. It has been worked to a depth of 110 feet, and at 90 feet levels have been driven 75 feet in either direction.

The length of the vein on the property is 900 feet; the strike is N. 20° W., and the dip 65° to 70° N. E. The vein matter is made up of silicified schists with seams of brown ore and quartz; in depths sulphurets are abundant. The width of the vein occasionally reaches 9 to 10 feet, but the ore seams range from 4

inches to 2½ feet in thickness. Some assays of average samples from the head of the north and south level gave $12 to $13 per ton. An assay of an average sample of the brown ore seams ran $28; and of the dump-pile, after sorting out the sulphurets, $13. The sulphurets, which had been sorted out, gave $48.00. Other assays of the ore from this mine gave:

Assays, Ores from the Chapman Mine, Mecklenburg County.

	(233)	(234)	(235)	(236)	(237)
Gold, per ton	$ 4.13	$ 20.67	$ 22.74	$ 23.77	$ 35.14
Silver, per ton	trace	trace	1.29	1.10	.74
	$ 4.13	$ 20.67	$ 24.03	$ 24.87	$ 35.88

The Dunn Mine is 2 miles northwest from the Alexander, towards Rozzel's ferry, on the west side of Long creek.

It was the first mine discovered in the county, not long after the finding of the nuggets at the Reed mine in Cabarrus county, in the first years of the present century.

The "East vein" was the first to be mined, but the ore soon changed to copper pyrites, which, though auriferous, proved to be too refractory to be treated by the methods then in vogue, and the vein was abandoned after working to a depth of 20 feet. Above this point the ores were mostly peroxidized. The vein is 6 to 12 inches wide; its course is nearly north and south, and its dip west.

The deposit which has been most largely worked is known as the Main vein—a body of slates bearing northeast and southwest, and dipping southeast at an angle of nearly 45°. This body of slates extends across the property for a distance of ¼ mile along its outcrop. It contains deposits of quartz and brown ores (including a very hard red hematite, more nearly resembling specular iron), cellular quartzose ores, and compact pyrites, including some copper pyrite. Another "vein" is found 50 feet back of this, but the sections indicate that the whole is one body, with a front and a back seam of ore, and not properly two veins. The appearance at the 60 foot level, where three bodies of ore are seen within a few feet of each other, gives strength to this view, that they are subordinate seams of the same vein, and makes it a

not unreasonable supposition that they may combine in depth to form one ore body.

The underground work consists of a shaft 60 feet deep, and a second shaft of 90 feet, which is considerably to the east of the veins; a cross-cut has been driven from the bottom of this shaft to meet the veins. The 60 foot shaft is connected with the 90 foot shaft by a level (the 60 foot level) across the formation. Three, if not four parallel bodies of ore are cut across by this level. These bodies are composed of silicified slates, varying from 3 to 5 feet each in thickness, and with an aggregate thickness of not less than 12 feet. No drifting had been done on these parallel bodies, and their character and strength is not known.

The following assays show the variation of different samples of ore:

Assays, Gold Ores, Dunn Mine, Mecklenburg County.

	(238)	(239)	(240)	(241)	(242)
Gold, per ton	$ 8.27	$ 10.33	$ 28.94	$ 128.44	$ 26.17
Silver, per ton	trace	trace	1.94	trace	trace
	$ 8.27	$ 10.33	$ 30.88	$ 128.44	$ 26.17

Nos. 238 241 were samples of ores from upper portion of the mine.
No. 242 was a sulphuret sample.

The Cathey Mine is 5 miles southwest of Charlotte. A large body of chalcopyrite was uncovered in the workings, and the ore was shipped from the State for reduction. A depth of 75 feet was attained when work was suspended.

The McCorkle Mine is 8 miles southwest of Charlotte. The workings extended to a depth of 50 feet, and the ores were brown oxides, and iron pyrites.

A third group of mines is found from 5 to 7 miles north of Charlotte, including the Henderson, Ferris, and others.

The Henderson Mine is situated 7 miles north of Charlotte. The longitudinal extent of the workings appear to have been fully 300 feet. The strike of the vein is N. 40° E., and the dip S. E. The deepest shaft is 100 feet, and three bodies of ore were worked from it; they vary in size from 1½ to 4 feet in thickness; in the lower workings the sulphurets predominate, but the brown ores had not entirely disappeared. Assays show variations from $14 to $75 per ton.

The John P. Hunter Mines are situated from 1 to 2 miles southwest of the Henderson. Judging from the outcrops and the float ore, there appear to be 5 veins; but only one of these has been prospected, and that only to a depth of 25 feet. The strike is N. 40° E., and the dip S. E. The Elwood vein is ¾ mile further west.

The Ferris (Faires) Mine is situated 6 miles north of Charlotte. There are two veins on this tract, and a third on an adjoining tract. The two veins first mentioned are believed to unite towards the south, and to form the third vein alluded to—the Garris vein.

The "North" vein has been worked most extensively. The "South" vein is 300 to 400 feet southwest of the former; it strikes N. 25° E., and dips 45° S. E. In width it varies from 2 to 7 feet, and has a pay streak from 18 inches to 4 feet wide. The rich brown ores of the upper levels give place at greater depths to sulphurets, and at the 90 foot level these are quite compact. The ores carry some chalcopyrite. The following tables give the results of assays of both the brown ores and the sulphurets:

Assays, Brown Ores, Ferris Mine, Mecklenburg County.

	(243)	(244)	(245)	(246)	(247)	(248)
Gold, per ton	$ 13.43	$ 18.60	$ 28.94	$ 40.31	$111.62	$126.09
Silver, per ton	2.80	1.81	trace	4.72	trace	2.57
	$ 16.23	$ 20.41	$ 28.94	$ 45 03	$111.62	$128.66
Copper, per cent	14.23%					

Assays, Sulphurets, Ferris Mine, Mecklenburg County.

	(249)	(250)	(251)
Gold, per ton	$ 40.31	$ 72.34	$506.41
Silver, per ton	4.72	trace	7.52
	$ 45.03	$ 72.34	$513.93
Copper, per cent	13.66%		

The Garris vein is the one at present worked. It shows a large outcrop, and is entered by two shafts, one 90 feet and the other 120 feet deep. The vein fissure strikes N. 25° E., and dips 70° N. W. It is stated to vary from 2½ to 5 feet in width, and is composed of seams up to 12 inches in thickness of milky quartz, carrying iron and some copper sulphurets, and separated by hydromicaceous schists. The ores are worked in a chilian mill of 3 tons capacity. It is stated that the quartz contains nearly 25 per cent. sulphurets, the concentrates from which

assay $45 to $60 per ton. Some assays of ore from this vein give the following results:

Assays, Gold Ores, Garris Vein, Ferris Mine, Mecklenburg County.

	Gossan. (252)	*Kidney Ore.* (253)
Gold, per ton	$ 5.17	$53.74
Silver, per ton	trace	trace
	$ 5 17	$53.74

Other mines in this group are the Alexander, northwest of the Ferris, and the Nolan and Caldwell mines.

A fourth group of mines is situated in Providence township near Sardis church, some 5 to 10 miles southeast of Charlotte: among others the Hunter, Tredinick, and Ray mines.

The Hunter Mine is 5 miles southeast from Charlotte, near Sardis church. There are two veins, and outcroppings of several others, but there is no record of the amount of work done, nor of the extent of the ore bodies. Recent explorations show a small amount of ore still accessible, assays of which ran from $20 to $45 per ton.

The Tredinick Mine is 7 miles southeast of Charlotte. It has been prospected to a depth of 80 feet, and for a length of 200 to 300 feet. The vein is 1 to 2 feet wide, and carries a relatively large amount of copper minerals.

The Ray Mine is situated from 9 to 9½ miles southeast of Charlotte, and within one mile of Matthews. It is the property of the Baltimore and North Carolina Mining Company, comprising 360 acres of land. There are 5 veins with an aggregate length of about 4 miles. The South vein has been worked to a depth of about 60 feet, and the Phifer Grove vein to a depth of 40 feet. The mine material from both was free-milling brown ore. The Ray vein, the best known of them all, is entered by 6 shafts, the deepest being 250 feet. The ore seam is 6 to 8 inches thick, and is filled with nearly compact sulphurets. Most of the ore, down to the 120 foot level, has been stoped out. The levels from the southernmost shaft uncovered a large and fine body of auriferous chalcopyrite. The following assays of ore from this mine are appended:

Assays, Gold Ores, Ray Vein, Ray Mine, Mecklenburg County.

	(254)	(255)	(256)
Gold, per ton	$ 20.67	$ 31.01	$ 223.23
Silver per ton	.32	.97	3.88
	$ 20.99	$ 31.98	$ 227.11

Assays, Gold Ores, Phifer Grove Vein, Ray Mine, Mecklenburg County.

	(257)	(258)
Gold, per ton	$ 20.67	$ 31.00
Silver, per ton	.32	.97
	$ 20.99	$ 31.97

The Pioneer Mills group of mines in Cabarrus county (see p.125) extends into the southeastern part of Mecklenburg county. The Johnson, Stinson, Rhea, Maxwell, Simpson, and Black mines belong here.

The Simpson Mine is in Clear Creek township, 10 miles east of Charlotte. The property has several veins, which carry quartzose ores, with a little sulphurets, including chalcopyrite. Assays of the ore show values from $1.00 to $45.00 per ton.

The Black Mine, 10 miles east of Charlotte, has a small but very rich vein of brown ore, of which assays show values from $50.00 to $236.00.

In Clear Creek township, 10 to 12 miles a little south of east from Charlotte, is an interesting group of mines. The grouping comprises two series of veins striking in diverse directions; one approximately northeast and southwest, and the other N. 60° W.

Of the northeast and southwest running series the most northerly vein is the Beaver, ½ mile east of Mungo's store; then two parallel veins, the Brafford and Ellington; and about 300 yards still further south, the Surface Hill.

The Ellington in its middle portion is known as the Blair, and in its southwestern continuation as the Hard Hill vein.

The second series of veins (northwest and southeast running) is something like one mile further west, and ½ mile southwest of Mungo's store. The mines in their order, commencing at the north, are: The Ferguson Hill, A. J. Wilson, Shaffer, and the Poplin.

The Survey has no detailed information respecting the Beaver, the Brafford or the Ellington.

The Surface Hill Mine has long been known for its large yield of nuggets. It is situated on a high plateau in Clear Creek township, from which flow McAlpine's creek to the southwest, Reedy creek to the northeast, and Clear creek to the southeast.

The country rock is granite, which is apparently intersected by a system of reticulated quartz veins or veinlets; and these, in consequence of the general disintegration, have scattered their contents widely over and beyond the 66 acres comprising the tract. There appear, moreover, to be two veins of some size crossing each other, viz: the main or Harris vein striking N. 45° E., and the Lidner or Vivian vein striking N. 10° W.

The rich pocket of nuggets, which has given the mine its celebrity, appears to lie near the junction of the two veins, and a little to the north, where a dike has cut across them. It is stated that the nuggets were found most abundantly between the dike and the north end of the Harris vein. It is quite certain that several thousand pennyweights must have come from the space of a few square feet.

A considerable amount of brown ore of good appearance, carrying copper sulphurets, has been mined in the process of hunting for nuggets, but as an ore it is of little value, despite its fine appearance. Assays show but $2.00 to $3.00 per ton.

The A. J. Wilson Mine was first opened in the early part of 1895, to a depth of 30 feet. The vein is of considerable width but has not been exposed from wall to wall. The pay streak was from 8 to 14 inches, carrying compact hematite and some pyrite. The strike is N. 63° W., and the dip 55° N. E. The assay of an average sample showed $13.80 per ton.

Little is known of the Shaffer, Ferguson Hill and Poplin mines, all of which have been extensively worked, but whose records have long since disappeared.

On the Elliotte plantation, 5 miles south of Charlotte, are 6 veins, but none have been prospected. Five of these are grouped in a space of ½ mile; they range from 3 to 6 feet in thickness, and carry quartz, brown ore and sulphurets. Assays of the ores show results ranging from $6.00 to $45.00 per ton of gold and silver, and some copper.

CHAPTER VI.

THE KINGS MOUNTAIN BELT AND ITS GOLD DEPOSITS.

This belt occupies an area of indefinite and imperfectly known boundaries, adjoining the Carolina Igneous Belt on the west. The localities in which mines are situated are few and widely scattered, in Gaston, Lincoln, Catawba, Davie and Yadkin counties.

The country rocks are crystalline schists and gneisses, and occasional lenticular bodies of siliceous, magnesian limestone and beds of quartzite. The strike of the schistosity is northeast, and the dip usually westward, at steep angles. The gneisses are micaceous; the schists, micaceous, chloritic, argillaceous, and sometimes graphitic. Pegmatite dikes are frequent in some localities, and in the Kings Mountain district of Gaston and Cleveland counties they are tin-bearing. The quartzites are apparently confined to the higher ledges of Kings, Crowders, Anderson, etc., mountains, a line of isolated peaks and ridges stretching from the South Carolina line northeastward. The limestone occurs along the foothills and low lands bordering these ridges, in small, irregular lenticular bodies, usually separated by slates or schists, and often buried without cropping out on the surface.

GASTON COUNTY.

The Kings Mountain (or Catawba) Mine[1] is situated 1½ miles nearly south of Kings Mt. station on the Southern R. R. It lies in the narrow limestone belt, which skirts the western base of Kings and Crowders mountains.

The ore is a mixture of the siliceous magnesian limestone and quartz, and exists in large lenticular chimneys, pitching to the northeast. The strike is N. 20° E., and the dip 45° to 60° westward. It is stated that five ore lenses or chimneys, which extend to the surface, have been opened. In length they reach 100 feet,

[1]Geological Report of the Midland Counties of North Carolina. E. Emmons, 1856. pp. 168, 169.

and in width 20 feet. They are separated by black, graphitic slate, carrying coarse crystalline iron pyrites, which are, however, stated to be barren. The total width of the ore bearing ground is from 60 to 150 feet. At one point in the mine the limestone is horizontally banded, blue and white; the schistosity of the slates is at a steeper angle, and it would appear that both the limestone and slate were sedimentary.

The gold is present largely in the free state; the sulphurets (pyrite, chalcopyrite and galena) aggregate from 2 to 3 per cent; tellurides are of occasional occurrence.

The mine was discovered in 1834, and is said to have yielded $750,000.00 during its past history. It has been opened to a depth of 320 feet, and was last worked in a small way during the past summer (1895). The equipment consists of a 30 stamp mill with 5 Frue vanners.

The value of the ore is difficult to estimate intelligently. Various assays show the following results:

Assays, Gold Ores, Kings Mt. Mine, Gaston County.

	(259)	(260)	(261)	(262)	(263)	(264)	(265)
Gold, per ton	$ 2.27	$ 3.10	$ 3.93	$ 4.96	$ 5.17	$ 6.21	$ 6.21
Silver, per ton	trace	.32	.23	trace	.62	trace	.77
	$ 2.27	$ 3.42	$ 4.16	$ 4.96	$ 5.79	$ 6.21	$ 6.98

	(266)	(267)	(268)	(269)
Gold, per ton	$ 12.40	$ 16.33	$ 39.27	$ 76.48
Silver, per ton	1.58	1.97	1.76	3.36
	$ 13.98	$ 18.30	$ 41.03	$ 79.84

Perhaps from $4 to $6 per ton will be nearer the present average value. The fineness of the gold is about 920. The concentrates are reported to run from $35 to $40 per ton.

There is still some placer ground to the east of the mine workings.

The Crowder's Mountain (or Caledonia) Mine is 4 miles east of the Catawba, and on the east side of Kings Mt., just over the gap between the two mountains. The country rocks are sericitic and chloritic schists, sometimes silicified, and often ferruginous, i. e. highly charged with magnetite or hematite. Certain narrow zones or belts of the schists are slightly mineralized with iron and copper pyrites; occasionally the width of the ore bearing

belt rises to 8 or 10 feet. The ores are commonly low in grade. The results from a number of assays are as follows:

Gold Ores, Caledonia Mine, Gaston County.

	(270)	(271)	(272)	(273)	(274)
Gold, per ton	$ 5.17	$ 1.03	$ 3.62	$ 9.10	$ 9.10
Siler, per ton	trace	trace	trace	trace	2.71
	$ 5.17	$ 1.03	$ 3.62	$ 9.10	$11.81
Copper, per cent			1.08%	0.19%	6.82%

The Patterson Mine is ¼ mile northeast of the Caledonia, and has similar ores.

The Rhodes Mine is 18 miles southwest from Charlotte. The ore body is auriferous mica gneiss; it has been worked to a depth of 100 feet, and for a length of 300 feet. Galena is occasionally found.

The McLean (or Rumfeldt) Mine is 15 to 16 miles southwest from Charlotte. It has been prospected probably for a length of 200 yards, and to a depth of 110 feet. The vein is filled with quartz carrying iron pyrites, and is from 1 to 6 feet in width. There is still some placer ground on the property.

The Duffie Mine is 16 miles west of Charlotte on the Tuckaseegee road. The vein is from 2 to 10 feet wide, and has been worked to a depth of 110 feet, at which point a large body of low grade sulphurets was found. Some assays show the following values.

Assays, Gold Ores, Duffie Mine, Gaston County.

	(275)	(276)	(277)	(278)	(279)	(280)	(281)
Gold, per ton	$ 4.14	$ 5.17	$ 4.92	$ 10.33	$ 12.40	$ 13.43	$ 16.54
Silver, per ton	trace	.75	2.56	.91	.66	.65	.58
	$ 4.14	$ 5.92	$ 7.48	$ 11.24	$ 13.06	$ 14.08	$ 17.12

The Robinson Mine adjoins the Duffie, and its ores are similar in character to those from that mine. Several assays of these ores give the following results:

Assays, Gold Ores, Robinson Mine, Gaston County.

	(282)	(283)	(284)
Gold, per ton	$ 3.45	$ 4.13	$ 9.31
Silver, per ton	trace	.13	.52
	$ 3.45	$ 4.26	$ 9.83

The Derr and the Rhyne mines are about 17 miles west of Charlotte.

The Burrell Wells Mine is situated 3½ miles south of the Duffie; there are 4 veins; the deepest workings are less than 50 feet. Some spots of placer ground still exist, which are washed at intervals.

The Oliver Mine is situated 12 miles northwest of Charlotte, on the west side of the Catawba river. It is believed to have been among the earliest operated mines in the section, and there are traditions of work here, which was done prior to the Revolutionary war. It has been worked for a distance of 100 yards; sulphurets appeared at a depth of 75 feet, notably galena, which was rich in gold.

The Farrar Mine is ½ mile beyond the Oliver.

The Long Creek Mine is situated 6 miles northwest of Dallas, the county seat. The property comprises about 600 acres. There are three veins, the Asbury, Dixon and McCarter Hill. The country schists strike N. 20° to 25° E., and dip generally 85° N. W. The quartz veins are approximately conformable to the schistosity. The Asbury vein has had some extraordinarily rich shoots of ore, which carried iron and copper pyrites, galena, zinc-blende, mispickel, and carbonate of bismuth. Its width was from 6 to 8 feet. It has been opened by two shafts, 45 feet apart, and worked to a depth of nearly 140 feet.

The Dixon vein has been extensively worked along the surface by pits, and two shallow shafts, 300 feet apart, from which drifts were run 79 feet south and 107 feet north. The thickness of the vein was a little over 3 feet.

The McCarter Hill vein has been entered by three shafts, within a distance of about 250 feet, and was stoped to a depth of 160 feet in the ore shoot, which pitches to the north, and increased longitudinally, until at the 140 foot level it had a length in the vein of more than 211 feet; the width ranges from 4 to 6 feet.

The last work at this mine was done on the McCarter Hill shoot in 1892. The assay value of the ore mined is stated to have been $8.00 per ton, of which about $3.00 was saved in the mill, and the concentrates ran $24.00 per ton.

LINCOLN COUNTY.

There is no mining work being done in Lincoln county, beyond desultory developments by small parties, though several mines have in the past been worked extensively; prominent among these latter are the Burton and the Hoke mines, near Lincolnton.

The Hoke Mine has been sunk to a depth of 110 feet, and drifts run for some length.

The Graham Mine is situated about 4 miles northeast of Iron Station on the Carolina Central R. R. The vein is from 30 to 42 inches wide, and has been prospected by pits along nearly 100 feet of the outcrop. The ores contain some copper, and occasionally the material becomes a true copper ore.

CATAWBA COUNTY.

In Catawba county the Shuford mine is the only one where regular operations are carried on.

The Shuford Mine is situated 4½ miles slightly south of east from Catawba Station on the Western North Carolina R. R.

The mining tract comprises 425 acres, but the workable portion of this tract embraces only 20 acres. This latter area is covered with auriferous quartz, and the soil is also auriferous. The underlying schists and gneisses are penetrated by seams of auriferous quartz, which run in every direction; but of veins, in any mining sense of that term, it may be doubted if there are any, although some of the seams, 12 inches or so in thickness, have considerable persistency in length and depth, and some general parallelism with the schistosity. The entire surface is "pay" material. The strike of the schists is N. 30° E., and the dip easterly. The mine is best adapted to a combination hydraulicking and milling process (Dahlonega method). The supply of water is always the most important consideration in work of this nature, and at the Shuford the supply is not large. The last work was directed to the exploration of the quartz seams in depth.

The A. D. Shuford Mine, ¾ mile southeast from the above, is very similar in character.

Some work was done in the early part of 1895 at Maiden, about 5 miles south of Newton; and at several points near Newton, and at the McCorkle and the England mines. To these may be added

the Rufty mine, just outside of the limits of Catawba Station, and the Abernathy, 6 miles east of Maiden.

DAVIE COUNTY.

In the gneissoid rocks of Davie county there are several localities where gold has been mined at one time or another.

The Butler (or County Line) mine is 8 miles southeast of Mocksville. The ore body is reputed to have been large, though of low grade. Callahan Mountain was worked a generation ago, but with what results is unknown. The Isaac Allen mine is 1 mile northwest of Mocksville. There are deposits of gold in Clarksville township, 7½ miles northwest of Mocksville; also in Fulton township, 7 miles northeast.

YADKIN COUNTY.

The Dixon Mine is situated 8 miles southeast of Yadkinville, the county seat. It was discovered in 1894. The following information is from Mr. Richard Eames, Jr., M. E., of Salisbury, N. C.: "The country rock is decomposed mica schist, sometimes chloritic, and intersected in places by diabase dikes. The vein is quartz, and on the outcrop shows a width of 4 feet. It has a steep dip to the northwest.

"A shaft has been sunk to a depth of 35 feet, at which point the vein holds its width of 4 feet. At this level drifts have been run 50 feet northeast, and 60 feet southwest. The vein from the shaft holds good each way for 25 or 30 feet, where it begins to be broken, and runs off into the laminae of the schists, making lenticular deposits and stringers. At places small stringers of kaolinitic matter intersect the vein at right angles, and are rich in gold for a distance of 2 feet from the vein, beyond which point they have no trace of gold. The value of the ore (quartz) is not uniform, as the following assays will show: outcrop at shaft, $36 per ton; 15 feet down, $10 per ton; 35 foot level, average, $7 per ton; rich specimen in 35 foot level, $40 per ton; poorest looking white quartz, $2.40. Milling results on small lots have given an average of $5 per ton.

"Some sulphurets of iron and copper are beginning to show in the ore."

There are no other important occurrences of gold in Yadkin county, so far as known at present.

CHAPTER VII.

THE SOUTH MOUNTAIN BELT AND ITS GOLD DEPOSITS.

GENERAL DESCRIPTION OF THE REGION.

The South Mountains form one of the prominent eastern outliers of the Blue Ridge, in Burke, McDowell and Rutherford counties. This region is the nucleus of one of the important belts of auriferous rocks in the State, and comprises an area of some 250 to 300 square miles, extending from Morganton to near Rutherfordton, a distance of about 25 miles, with an average width of 10 to 12 miles.

To the north of Morganton the more or less isolated occurrences of gold in northern Burke, Caldwell and Wilkes counties on the east side of the Blue Ridge may be considered as belonging to this general belt. So also, to the south of Rutherfordton, the deposits of Polk county, extending into South Carolina, will be included here.

But the South Mountain region, proper, as above outlined, is by far the most important part of the belt, and will form the principal topic of the following descriptions and discussions. The accompanying contour map[1], Plate XII., shows the location of the most important gravel deposits and mines in this region.

TOPOGRAPHIC FEATURES OF THE REGION.

The South Mountain range rises to a maximum altitude of 3,000 feet above sea level. The average elevation above the sea of the old base level, which is a prominent feature in this region, is 1,300 feet. This old plateau is dissected by the drainage, and gradually descends to 1,100 feet above sea level at the Catawba river, the main stream on the north. The country is drained on these north-

[1] From revised surveys of the U. S. Geological Survey, made in 1894, by Mr. Chas. E. Cooke, topographer. To such persons as may be particularly interested in this region, the Geological Survey will be glad to supply with a map, of larger scale, with 50 foot contours.

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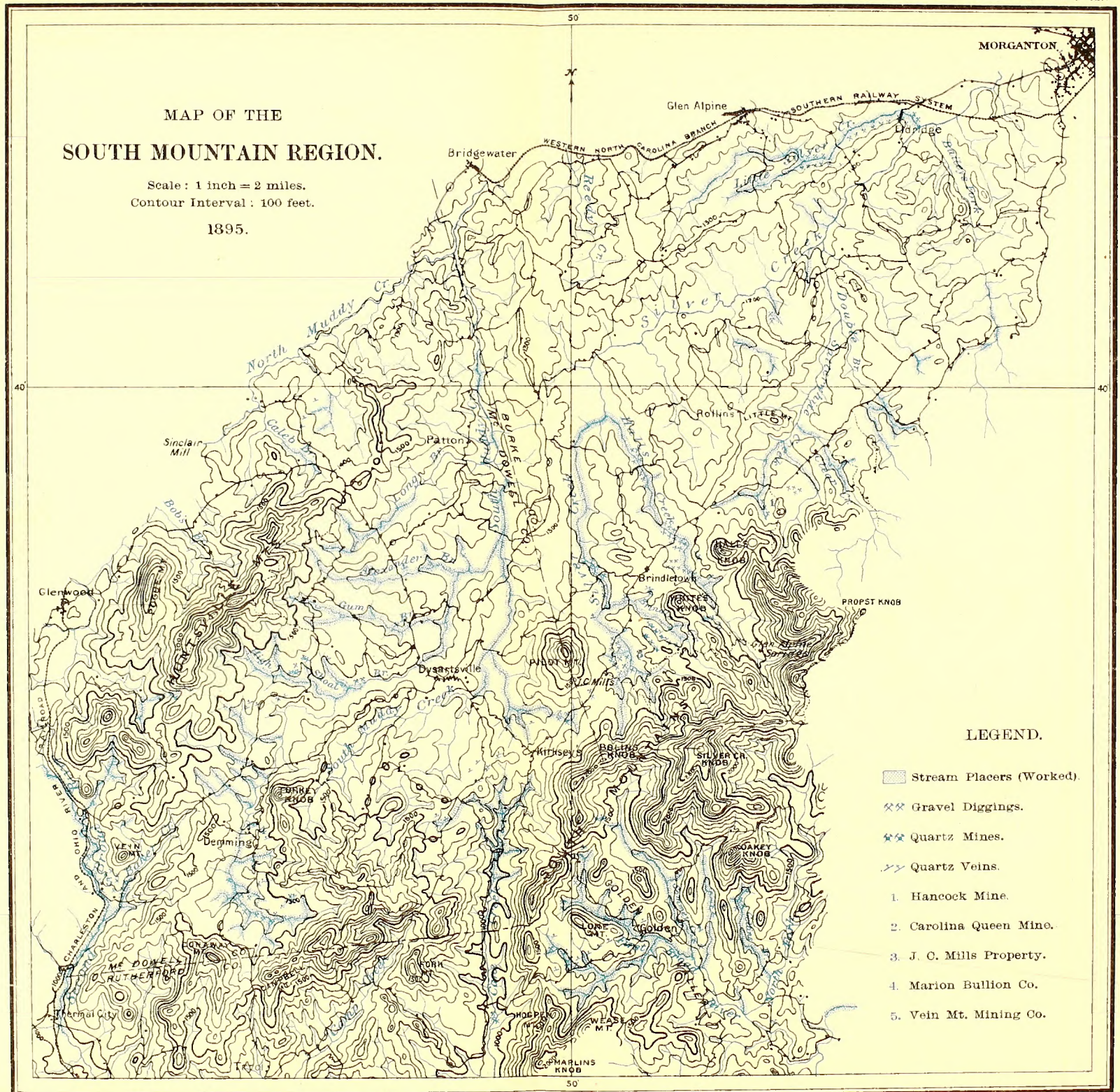
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MAP OF THE
SOUTH MOUNTAIN REGION.
Scale: 1 inch = 2 miles.
Contour Interval: 100 feet.
1895.
MORGANTON
Glen Alpine
SOUTHERN RAILWAY SYSTEM
Bridgewater
WESTERN NORTH CAROLINA BRANCH
Dildge
Rocky Creek
Little Silver Creek
Silver Creek
Buffalo Creek
Big Buffalo Creek
North Muddy Cr.
Caleb's Cr.
Long Branch
Bobs Br.
Boulder Br.
Gum Br.
South Muddy Creek
Hunting Creek
Sinclair Mill
Patton
BURKE
McDOWELL
Rollins
LITTLE MT.
Brindletown
HALES KNOB
YATES KNOB
PROPST KNOB
Glenwood
Dysartsville
PILOT MT.
J.C. Mills
Kitsey's
BOLING KNOB
SILVERTA KNOB
OAKEY KNOB
TUNNEL KNOB
Demming
KEYN MT.
KEYN
MARION
CHARLESTON
McDOWELL
RUTHERFORD
CONLEY MT.
CONLEY
Thermal City
Golden
LORE MT.
GOLDEN
HOPPER MT.
WEASE MT.
MARLINS KNOB
LEGEND.
Stream Placers (Worked).
Gravel Diggings.
Quartz Mines.
Quartz Veins.
1. Hancock Mine.
2. Carolina Queen Mine.
3. J. C. Mills Property.
4. Marion Bullion Co.
5. Vein Mt. Mining Co.

ern slopes by Silver and Muddy creeks, flowing into the Catawba river, and on the south by the First Broad and the Second Broad rivers.

HISTORICAL: THE BECHTLER COINAGE.

Gold was first discovered in Burke county in 1828 in the bed of Brindle creek, one of the small tributaries of Silver creek, which has its source in the South mountains.[1] Soon every stream in the neighborhood was prospected and panned with golden success. Large slave owners found a new and profitable use for their slaves, and many thousands of them were put to work in this new field. Placer mines were opened and operated on a large scale, though by primitive methods, the pan, rocker, long tom, and sluice box being the only implements at that time—and, indeed, these are still used in portions of this region to-day. Mining was at first confined to the stream gravels, which were generally rich. Later on the upper decomposed layer of the country rock and the more ancient placers, formed by secular disintegration and drift, were worked. A large amount of gold was produced in this way, but it is impossible to even approximate the amount, as absolutely no records were kept. The best authorities place the amount at between two and three million dollars.

There being but one U. S. mint established by the government at that time (at Philadelphia), and the means of transportation to that distance being attended with difficulty and great loss of time, the miners naturally looked about for some other means of converting their gold into a circulating medium on the spot. In 1831 a German, named Christian Bechtler, a jeweler by trade, living about 3 miles from Rutherfordton in Rutherford county, proposed to the miners that he would coin their gold for a small percentage. His proposition was accepted, and a large quantity of gold was coined in one, two and a-half, and five dollar pieces, with the name of "C. Bechtler, Rutherford County, N. C.," on one face, and on the reverse side the value, number of grains, and carats fine. The United States government instituted an investigation and upon finding that the assay value of the coins was always equal to, if not

[1] The story of the first discovery is given by Col. T. G. Walton, of Morganton, N. C., in an article which appeared in the *Morganton Herald* of March 15th, 1894.

somewhat greater than the denominational value, their circulation was not disturbed. The percentage paid by the bullion holders for coinage was $2\frac{1}{2}$ per cent. Bechtler continued the mintage of these coins until his death in 1843, after which his nephew, C. Bechtler, Jr., continued until June, 1857. Sometimes as much as $4,000 to $5,000 were coined in a week, and for about 10 years the annual quantity was pretty equal. As no records of the quantities coined are in existence, it is impossible to even estimate the amounts of gold consumed here.[1]

These coins are now rare, and command a premium.

GENERAL GEOLOGIC AND PETROGRAPHIC NOTES.

The subaerial decay of the rocks is universal, and extends to a depth exceeding 100 feet in places; though the average thickness of the decomposed layer may be taken at about 50 feet. This fact will explain one of the great difficulties in studying the lithology, not only in this, but in every other portion of the State.

The rocks of the South Mountain Region are for the most part mica and hornblende gneisses and schists, having an eminently lenticular structure. They are often garnetiferous, and contain besides, many rare minerals, especially those of the rare earths, such as zircon, monazite, xenotime, fergusonite, etc. The primary origin of these gneisses is looked upon as being igneous granitic and dioritic rocks of Archean age, which have subsequently been rendered schistose by the action of various dynamic forces.

Owing to frost action the superficial layers of the country rock, especially along the slopes of ridges, have undoubtedly suffered motion and displacement[2]; in many instances, therefore, the surface dips of the schistose laminæ must be considered anomalous.

The general strike of the schistosity may be taken at N. 10° to 25° W., and the dip 20° to 35° N. E. This applies to the central part of the region. To the northwest of South Muddy Creek and Vein Mt., and in Caldwell, etc., counties, the strike is generally northeast, and the dip southeast.

[1] Report on the Survey of South Carolina for 1857, by O. M. Lieber, p. 135.

[2] On the Action of Frost in the Arrangement of Superficial Earthy Material. By W. C. Kerr. Am. Jour. Sci., 1881, Vol. 21, III., p. 125; and Ores of North Carolina, Appendix C, 1887, p. 329.

The mica gneisses are composed essentially of quartz, feldspar and mica. Both muscovite and biotite are present, the latter usually predominating. Phlogopite is of rare occurrence, as in the gneiss near the headwaters of South Muddy creek, at the old Bracket-town reservoir. All of the feldspars, from the potash to the lime-soda types, are present at various times. Plagioclase appears to predominate, especially in the more basic phases of the rock. Micro-perthitic intergrowths were noticed in many specimens, and microcline is common. Hornblende and pyroxene are altogether absent, or present only to small extent, in the acid mica gneisses, increasing in quantity and becoming essential minerals in the more basic hornblende gneisses. The hornblendes usually show greenish pleochroism, sometimes verging to brownish in color. The extinction angles are often very high, as in the hornblende gneiss from the Bracket-town shaft, McDowell county, where it reaches 30°; however, the cross-sections are usually good and characteristic. The pyroxenes are monoclinic, in most cases apparently augite. They are colorless and non-pleochroic.

The usual accessory constituents of these gneisses are magnetite, pyrite, titanic iron ore, garnet, zircon, monazite, and other rare minerals.

Alteration products are numerous. The micas are frequently altogether gone over into hydrous varieties and carbonates; and bleached biotites are common. The feldspars are always affected to some extent, being at times partially, and often completely, altered to kaolin or sericite. Propyllitic changes to epidote or zoisite are not uncommon. The ferro-magnesian minerals alter to chlorite and epidote. Zeolitic alterations are seldom met with.

These various alterations have in places proceeded to such an extent as to entirely obliterate the original character of the gneiss; and one of the best examples is met with in certain portions of the mine rock from the Bracket-town shaft, where the changes may be followed from fairly fresh specimens. This altered rock is light greenish in color and fine-grained in texture; macroscopically the constituent minerals are indistinguishable,

and the mass resembles felsite. Under the microscope, however, small fragments of unaltered feldspar are still to be seen, though the main portion is entirely decomposed to sericite and carbonates. In the hornblendic gneisses from the same mine the change of the ferro-magnesian minerals is to epidote and chlorite.

Such phenomena as secondary quartz and chlorite veinlets seem to point to a hydro-metamorphic action rather than a dynamic one. The effect of the latter force, however, is seen in the undulous extinction, bending, fracture, and other strain phenomena, exhibited by the minerals.

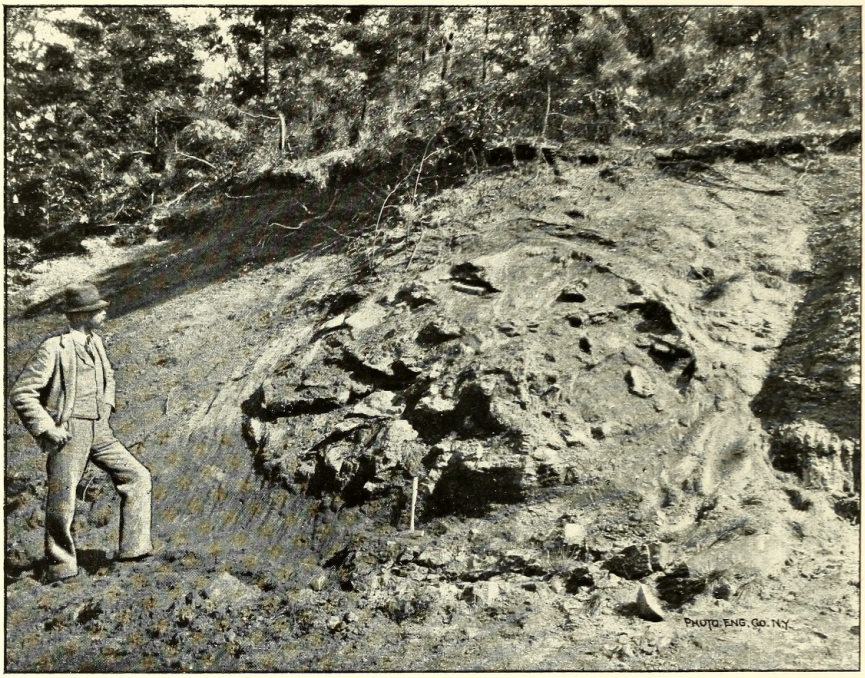
It is seldom that these rocks are porphyritic, as observed in a specimen collected from Brindle creek in Burke county, where the phenocrysts are plagioclase crystals up to $\frac{1}{8}$ inch in diameter. More generally there is a homogeneity in the crystalline structure of the minerals, which is micro-granitic.

Relative to each other the mica and hornblende gneisses occur in adjacent lenticular banded masses, from a few inches to many feet in thickness; and it appears in instances that they pass into each other by insensible transition phases between these acid and basic types.

Pegmatites are of frequent occurrence in the gneiss, and they contain such fumarole minerals as tourmaline and beryl. Their structure is usually lenticular, like that of the enclosing gneisses. The feldspar is largely microcline, and the same alterations occur as noted above for the gneisses.

At Brown Mt., in the northern part of Burke county, the country rock is a massive granite. True granitic rocks, however, besides the pegmatites just mentioned, exist in the South Mountain region proper only as small dikes, and the general rock decomposition makes these difficult to distinguish. The most pronounced one was found at a point about $\frac{1}{2}$ mile southwest of Capt. J. C. Mills' house on the Rutherfordton road. It is 3 inches wide, with a strike N. 20° W., and dip 80° N. E. It is a fine grained biotite granite, in which the feldspar is mainly microcline, with some orthoclase and micro-perthite, and the structure is micro-granitic. Similar dikes were observed at the

1



2



PYROXENE (1) AND AMPHIBOLITE (2) BLEBBS.—SOUTH MOUNTAINS.

Marion Bullion mine (Bracket-town), and Vein Mountain, in McDowell county.

Massive crystalline dioritic rocks are not uncommon in the South Mountain region, but whether they exist as dike formations or in larger bodies, it is as yet difficult to say. It appears probable that the former may be the case. They are usually fine grained, and composed of hornblende and a plagioclase feldspar, with very little if any quartz. The hornblendes show light to dark green, and at times blue to brown pleochroism. Among the accessory minerals apatite appears to be rather constant. The decomposition products are the usual ones, namely, sericite, kaolin, chlorite, epidote, etc.

Gabbroitic (augite-plagioclase) rocks are seldom met with, in fact the only occurrence noted was ½ mile south of the White House in the western part of Rutherford county.

There are no diabase dikes in the South Mountain region proper, but in the northern part of the general belt a heavy olivene-diabase dike extends persistently from near Hartland in Burke to the Baker mine in Caldwell county, the direction being about N. 20° W. At the latter point it is very wide and largely altered to serpentine.

Isolated, basic ferro-magnesian masses of pyroxenite and amphibolite occur sparingly throughout the South Mountain region as rounded inclusions in the gneiss. They are usually coarse crystalline and massive, devoid of schistosity. They vary in size from less than one to nearly one hundred feet in diameter. The schistose laminae of the gneisses are observed to bend around these inclusions, showing that they were formed before the force producing schistosity was exerted, which they resisted owing to their superior solidity and hardness. These masses are looked upon as basic segregations from the original igneous magma out of which the gneisses were formed. Their concentric structure becomes evident on weathering. So far as present observations go, their outcrop occupies a broken line, following the South Mountain chain in a direction approximately S. 60° W. Plate XIII shows above (1) a section of one of these smaller pyroxenite

blebs, partly altered to talc, to be seen in the bank by the road side, on Brindle ridge, Burke county. The lower half of this plate (2) is from a photograph of a much larger amphibolite bleb, which caps a low hill in the Turkey cove region, 1 mile north of Bracket-town, McDowell county.

The pyroxene in these rocks is monoclinic and non-pleochroic. In the amphibolites the hornblende shows light green pleochroism, though in one instance it was observed to be bluish green to yellowish brown. The extinction angles are sometimes very high, 24° and even 30°. The usual accessory minerals are magnetite and pyrite, which are sometimes present in considerable quantities. These rocks are universally altered to serpentine or talc, often completely so; and the serpentine possesses the characteristic fibrous grated structure, common to that formed from pyroxene or amphibole.

THE GOLD-BEARING QUARTZ VEINS.

The auriferous quartz veins of the South Mountain region are true fissure veins. Indeed the fissure system is the most regular, persistent and remarkable, from a point of almost absolute parallelism, in the State. The strike is N. 60° to 70° E., and the dip is from 70° to 80° N. W. The thickness of these veins varies from a mere knife edge to four feet. The great majority are from less than 1 to 3 inches thick, the larger ones (1 to 4 feet) being few and far between. They appear to lie in belts, composed of scores of small veins close together, and there seems to be some regularity in the spacing between the large veins. Faulting has been noticed in but few instances, and there the throw was only from ½ to 3 inches, always in a normal direction. At the Marion Bullion mine one of the veins is stated to be cut by a granitic dike, and thrown 4 feet to the south; but this could not be verified, and will require some further investigation. The veins vary in thickness, both on the strike and in depth; but they hold their parallelism so far as at present explored (the deepest shaft in the district is 126 feet); and there is no reason for supposing, as is the quite general belief of the natives, that they will come together in depth; in fact this would be unlikely and exceptional. The veins themselves,

it is true, are sometimes split by "horses" of the country rock, and at times have stringers running off from them at an angle, but individually they will preserve their parallelism in depth.

The ore or filling of the fissure veins is quartz, usually of a milky white color, generally saccharoidal, and seldom, if ever, vitreous or glassy. It is often stained brown and is cellular from decomposed sulphurets. The stained, saccharoidal quartz is usually the richest. Sulphurets occur below the water-level; these are pyrites, galena, chalcopyrite and sphalerite. All observations go to show that the vein matter is formed from ascending mineralized solutions. There is no evidence of replacement of the country rock by ore.

There is another system of quartz bodies, which lie interlaminated in the gneisses as small, discontinuous lenses. This quartz is glassy, contains some mica and feldspar, and is barren. It is locally known as "water-quartz."

DISTRIBUTION OF THE QUARTZ VEINS.

The quartz veins appear to be concentrated in aggregates along parallel belts or zones within the general ore bearing region. So far as can be asserted at present there are five (5) such principal belts. (This is subject to revision on further investigation.)

(1) The Morganton Belt; passing through Morganton, along Little Silver creek, and through the Neighbor's Place to near North Muddy creek.

(2) The Huntsville Belt, passing over the southern end of Huntsville mountain.

(3) The Pilot Mountain Belt, passing over Hall's Knob, White's Knob, Pilot Mountain, Bracket-town and Vein Mountain, to and beyond the Second Broad river.

(4) The Golden Valley Belt, passing across the upper end of the Golden Valley (valley of the First Broad river), and crossing Cane and Camp creeks to the Second Broad river.

(5) The Idler Mine Belt, about three miles north of Rutherfordton.

The maximum breadth, in a north and south direction, across the ore bearing formation as a whole is about seventeen (17) miles.

THE VALUE OF THE QUARTZ VEINS.

It is difficult to estimate with any degree of satisfaction the real value of these auriferous quartz vein deposits. Samples running several hundred dollars to the ton may be selected from the richer portions of the veins, but they are of course not representative. Other samples may show only a mere trace of gold and silver. From $5 to $20 per ton may be considered the more usual value of the average good grade of ore, dependent on the size of the vein. The wider veins are generally poorer in gold than the narrow ones. Wherever in this region there has been surface mining, many boulders are seen piled up which are evidently largely derived from veins of considerable size. Some assays of these large fragments, both from Brindletown and Golden Valley show only from $1.00 to $2.50 gold per ton. The fineness of the gold varies in different portions of the region[1]. Thus in the Brindletown district it is from 825 to 850; in McDowell county (Marion Bullion and Vein Mountain mines) from 780 to 800; in the Golden Valley, Rutherford county, 900; and in Polk county from 900 to 950.

METHOD OF WORKING THE QUARTZ VEIN DEPOSITS.

The great majority of these quartz veins are too small to be profitably worked individually, on any regular mining scale. The natives, both men and women, often hunt for and find the rich streaks of the small veins, which they mine in narrow open cuts, and extract the gold by crushing with another rock and panning. They frequently make from 75 cents to $1.50 per day in this way, of which they are supposed to pay a toll or royalty of $\frac{1}{8}$ to the owners.

When the conformation of the ground admits, and the gulches are deep enough, the whole formation, including many of the small veins of quartz, may easily be undermined to a great depth,

[1]See article by Mr. G. B. Hanna, Engineering and Mining Journal, Sept. 18, 1886; also "The Ores of North Carolina," 1887, p. 235.

and the whole mass washed down into sluices, and thence to the mill for battery treatment and amalgamation of the auriferous quartz and hard masses, as is the practise in the Dahlonega district, Georgia.

At the Carolina Queen mine in Burke county there stands a five stamp mill, which at one time treated the ore from a great number of small veins (2 to 4 inches), obtained by hydraulicking and sluicing; this mill is now idle. Capt. J. C. Mills of Brindletown, Burke county, has treated the ore from a series of small veins similarly in a small stamp mill, as he reports, quite successfully; his mill was destroyed by fire a number of years ago and never rebuilt.

Some of the larger quartz veins have been opened by shafts and underground drifts, as for instance the "Nichols" vein (18 inches to 3 feet) at Vein Mountain in McDowell county. At the Idler mine in Rutherford county a vein 22 inches thick has been opened to a depth of probably 100 feet.

However, no vein mining of any magnitude has yet been done in the South Mountain region. It has been altogether of a desultory and spasmodic nature. In the whole region there are but two well appointed stamp mills, namely at the Vein Mountain, and the Carolina Queen mines. The Marion Bullion mine is equipped with a Huntington mill. No proper attempt has as yet been made to concentrate and treat the sulphurets. If, as reported, there are regular bodies of ore in the district, ranging from 18 inches to 3 feet in thickness, and running from $5 to $15 per ton, it seems difficult to understand why they should not be the basis of highly profitable mining enterprises.

THE PLACER DEPOSITS.

The Placer Deposits are of three classes: (1) The gravel beds of the streams and adjoining bottom lands, deposited by fluviatile action; (2) the gulch and hillside deposits, or the accumulations due to secular disintegration and motion, induced by frost action and gravity; (3) the upper decomposed layer of the country rock itself, the rotten rock in place.

In the first class the gravel is waterworn, rounded to sub-angular, and the deposits are from 1 to 2 feet in thickness. In the second class the gravel is usually quite angular, and the deposits are from a few inches to several feet in thickness. In the third class gravel is of course absent, the washable ground consisting of the upper decomposed layer in place, and the gold being derived directly from the partially disintegrated quartz veins.

The gravel is for the most part quartz, and among the beds are frequently found fragments of quartz with threads, plates, and crystals of native gold. These fragments, in many cases, evidently represent the entire thickness of the veins from which they came.

DISTRIBUTION OF THE PLACER DEPOSITS.

The principal stream deposits are those of Silver and South Muddy creeks and their numerous tributaries in Burke and McDowell counties; the First Broad river and its tributaries in Rutherford county, and the Second Broad river with its tributaries in McDowell and Rutherford counties. All of these streams have their source in the South mountains.

Most of the easily accessible stream deposits have been exhausted, and placer mining is being more strictly confined to the deep gravel channels, the gulch, and the decomposed country deposits. Their distribution is very general along the bottoms, highlands and ridges drained by the previously mentioned streams, and the principal centers of operation are at Brindletown, Bracket-town and Vein Mountain.

VALUE OF THE PLACER DEPOSITS.

As no records have ever been kept it is not possible to say what the ground will yield in gold to the cubic yard. It is naturally quite variable from a few cents to as high as $20 a cubic yard.[1] But it will run more generally from 4 to 50 cents.

The character of this gold is usually quite fine, although in certain localities some coarse gold is found; the largest nuggets have been found in a gulch on the western slope of

[1] On Capt. J. C. Mills' land at Brindletown, Burke county, a small area of ground was worked by tunneling on a gravel channel, and gave a daily yield of $160 to a volume of ground 5 by 7 by 6 feet (about 8 cubic yards), or $20 per cubic yard.

Huntsville mountain in McDowell county. One weighing five (5) pounds was washed out here.

METHODS OF WORKING THE PLACER DEPOSITS.

Simple sluicing is the common method employed in working these gravel deposits. Both ground sluices and wooden sluice boxes are used. The former are from 20 to 50 feet in length, 20 inches wide and from 12 to 20 inches deep; they are simply trenches cut into the soft bed rock, being unlined and unpaved. The wooden sluice boxes are from 8 to 15 feet in length, 12 to 20 inches in depth, 20 inches in width at the upper and 18 inches at the lower end, so as to fit into each other in case more than one is used. Each box is fitted with from one to two riffles. The grade of the sluices is from 1½ to 3 inches per 100 feet. The head box is fitted with a "grizzly," or perforated iron plate, on which the dirt and gravel to be washed are charged. The sluices are then worked over constantly with gravel forks or perforated shovels, and the larger rocks and pebbles are thrown out.

The native miners, working on their own account, known as "tributers," ordinarily use a single sluice box, which they move from place to place, working spasmodically as the inclination strikes them. They pay a toll of 16⅔ per cent. to the owners of the land. Fron 75 cents to $1.00 per day is considered good work by them.

At the larger mines hydraulicking is employed, under a pressure of from 50 to 200 feet, with 12 inch mains, reduced to a 1½ inch nozzle. The hydraulic elevator has also been used successfully in raising the gravel to fall line.

WATER SUPPLY FOR PLACER MINING.

The numerous mountain streams afford a fairly good, though not over abundant, amount of water for mining purposes. These streams are small in size but their flow is unfailing throughout all normal seasons, and they can be concentrated by ditch lines in sufficient volume for sluicing and hydraulicking purposes at many points. The chief impediment is in the loss of grade before the mining ground in the foot-hills and bottom-lands is reached, due to the deep and numerous indentations in the mountains. Reservoirs are sometimes necessary to store the water, in

order to obtain a requisite supply and head. It is impossible to water some portions of the hillside ground, except by pumping into reservoirs constructed above.

There are several long ditch lines, augmented by flumes, in the region ; one of these is over 10 miles in length. The size of the ditches varies from 12 to 18 inches across the bottom, 20 to 30 inches across the top, and 12 to 20 inches in depth. The best grade is found to be from 1½ to 3 inches per 100 feet.

A considerable obstacle is often met with in the lack of sufficient dumping ground for the tailings, the grade of the streams being too small to carry off all of the sand. In some instances this could be overcome by freeing the larger streams from debris and drift wood, and in removing other natural impediments, such as shoals.

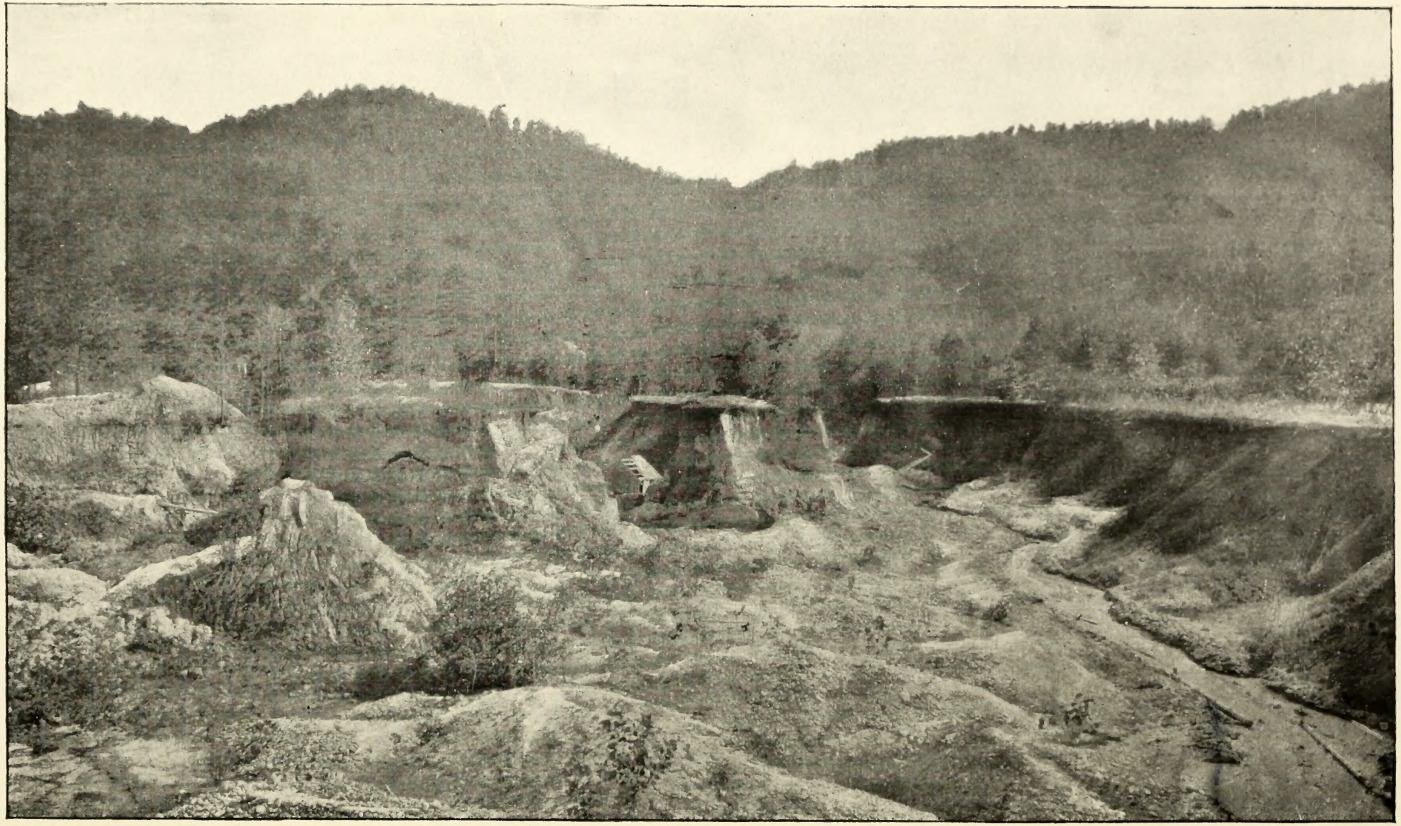
DESCRIPTION OF THE GOLD DEPOSITS AND MINES IN THE SOUTH MOUNTAIN REGION.

BURKE COUNTY.

The Hancock Mine is a placer digging situated at the foot of the northeast slope of Hall's Knob. The thickness of the gravel bed is from 1 to 1½ feet, and that of the overlay averages 25 feet. Directly above the gravel is a peaty bed, containing blackened stems and trunks of pine wood.

A sluice, 2½ miles in length, brings the needed water supply, with a head of 40 to 60 feet. When last visited (in the summer of 1895) the mine was being worked on a small scale by tributers. The gravel was under fall which necessitated its being worked in pits, and raised by shovel into the sluice boxes. A rough estimate made of one of these pits shows that the yield was about 14 cents per cubic yard.

The Carolina Queen Mine is situated on the northeastern slope of White's Knob, on Hall's creek. A series of small (1 to 3 inch) parallel veins has been hydraulicked and sluiced in the upper decomposed layer, over a width of about 300 feet of ground. One of these veins (the so-called "Fisher" vein) has



PLACER DEPOSITS, FOOT OF SOUTH MOUNTAINS ON THE NORTH. HANCOCK MINE.

been explored in a trench ¼ mile long to a depth of 50 feet. The material was sluiced to a 5 stamp mill close by, where it was milled. The ditch lines aggregate 5 to 6 miles in length. The strike of the quartz veins is N. 50° to 60° E., and the dip is 75° to 80° N. W. The schistosity of the gneiss strikes N. 20° W. and dips 20° N. E. The mine is now idle. The placer ground on Hall's creek has been practically exhausted.

The Hodge Property is situated on Silver creek, about 3½ miles north of Pilot mountain. It comprises considerable placer ground along the creek and adjoining bottoms, at present filled with sand and not workable, without the production of some artificial fall. During the summer of 1894 a number of prospect pits were sunk on the adjoining hills in garnetiferous, sillimanite schist, containing considerable secondary quartz, which was mistaken for gold ore. Several samples, some of which contained pyrite, were collected here by the Survey, assays[1] of which showed no more than the merest trace of gold, and a maximum of 1 ounce in silver. Further search for gold in this ground is ill advised.

The J. C. Mills Property at Brindletown covers a large territory on both sides of Silver creek, including the eastern half of Pilot mountain.

A vast amount of gold has been obtained here since the first discovery in 1828, and much of the gravel has been washed over three times with good results. Considerable work has been done on the hillside and gulch deposits, and much of this ground is still virgin and valuable. Some of the richest channels have yielded the exceptional output of $20 per cubic yard. (See p. 162.)

From Pilot mountain and along its lower slopes a number of gravel channels radiate in all directions, some of which have been located and worked as high as water could be obtainded, such as the White Bank and Magazine mines. But a large amount of virgin ground still remains here that has not been worked for lack of water. Pilot mountain is an entirely isolated peak, and the only means of obtaining water sufficiently high

[1] Assays Nos. 251, 252, 253 of the Survey laboratory series, by Dr. Chas. Baskerville for the N. C. Geological Survey.

for mining puposes, would be either by pumping into reservoirs, or by means of a siphon line (about 1 mile in length) from "Hard Bargain" gap, to which water could be brought from the headwaters of the First Broad river, in a ditch line from 15 to 20 miles in length.

The total length of the several ditch lines on this property is about 20 miles, with 4800 feet of fluming. The longest flume is 600 feet, and the highest trestle 28 feet. The grade is 1½ to 3 inches in 100 feet. The ditches are 18 inches deep by 24 inches wide. Cost of ditching is 25 cents per rod. The flumes are 18 inches wide by 12 inches deep. In places where the grade is less than the above mentioned the ditches and flumes are made wider. The head obtained is from 60 to 200 feet.

Along the waters of Brindle creek the quartz veins in the decomposed country have been hydraulicked and sluiced, but no regular vein mining has been attempted. The veins are small, with few exceptions, (one vein on the Mill's place is from 12 to 18 inches thick, but it is almost barren in gold, at least where exposed). They strike and dip in the normal direction. The strike of the crystalline schists averages N. 20° W., dip 20° N. E.

Altogether this has been the most extensively worked tract in the South Mountain region. During the past year the Piedmont Mineral Company, limited, erected a new hydraulicking plant with gravel elevators, and regular operations are probably in progress by this time.

McDOWELL COUNTY.

The Marion Bullion Company owns an extensive mining tract, situated at Bracket-town, in the valley of the headwaters of South Muddy creek. The accessible placer ground has been worked to the head of the present ditch line. By building new reservoirs and ditches at a greater elevation a considerable area of virgin ground might be made available here; and by removing several shoals in Muddy creek the fall of the same might be lowered sufficiently to work the stream and adjoining bottom gravels, heretofore inaccessible.

It is not possible to state any definite value of these deposits. In a general way, the hillside and gulch ground ranges from 4 to 50 cents per cubic yard, while the gravel of the bottom land will run as high as $1.00 per cubic yard.

A number of small quartz veins have been prospected on the property. The most extensive explorations in this direction were made during the past few years by sinking a vertical shaft (7 by 11 feet cross-section) to a depth of 126 feet on a series of six narrow quartz veins, lying close together.

The country rock is biotite gneiss striking N. 10° W., and dipping 15° to 20° N. E. It is lenticular in structure, and encloses lenses of a highly altered greenish sericite gneiss.

Near the outcrop the quartz veins vary from 1 to 6 inches in thickness, and are from 1 to 3 feet apart ; they are parallel and strike N. 68° E., dipping from 63° to 70° N. W. The prime object of the shaft was to ascertain whether these veins would grow larger and come together in depth, according to a popular but fallacious belief ; instead of this, they are found to pinch out to less than one inch at the bottom of the shaft, and to maintain their distance apart. Two small normal faults were observed in the veins, of as much as ½ inch throw. The quartz is saccharoidal, and mineralized with galena, blende, chalcopyrite and some pyrite. The wall rock itself, though not highly so, is impregnated with pyrite to a greater extent than the vein matter.

The quartz alone from these veins gives assay values ranging from $4.00 to $20.00 per ton in gold and silver. At the depth of 115 feet a sample of the entire shaft material, vein quartz and wall rock, assayed $4.80[1]. A test mill run was made in September, 1894, in a Huntington mill and two Frue vanners, situated on the property. Fifty-four tons of quartz and rock were treated; of this amount one-fourth was quartz from the 50 foot level in the shaft, three tons were float quartz, collected in hydraulicking on another part of the property, and the remainder was rock and vein quartz from the shaft. The result was 71 dwts. of free gold, caught as amalgam in the body of the mill beneath the stationary

[1] Assay No. 235 (of the Survey laboratory series) by Dr. Chas. Baskerville, assistant chemist, N. C. Geological Survey.

grinding plate, and on the Hungarian riffles; practically no gold was obtained from the silvered copper plates. The concentrates from the two Frue vanners amounted to 2 tons, which were so dirty that they were run over and reduced to 260 pounds. The tailings on this second run showed enormous loss, especially in galena and floured amalgam, due either to the inefficiency of the vanner or more probably to inexperience in operating the same. An assay[1] of the final concentrates showed only $7.88 per ton, and a sample of the tailings gave $2.63[2]. This is certainly discouraging. If further and more extended exploration can show that the entire rock mass, at least over a considerable width, in the bottom of the shaft and in the cross cuts, will average from $3.50 to $4.50 per ton, then, by careful and intelligent management the mine might be a profitable low grade proposition; but certainly no dependence can ever be placed on the small veins alone.

The Vein Mountain Property comprises a large tract of land extending from Vein Mt. on the Second Broad river in a northeasterly direction to Huntsville Mt., a distance of about 4 miles. The gulch deposits of Vein mountain have been hydraulicked to points as high as water was accessible by the ditch line, 16 miles in length. A careful and extensive examination[3] of the gravel still left in the gulches shows a range in value from 15½ cents to $1.28 per square yard of bed rock on which it lies; and a similar examination of the soil of Vein mountain shows from 5½ to 24 cents per square yard of bed rock. On the Vein mountain end of the tract there appear to be 37 acres of superior gravel, ranging from 39½ to 55 cents, and 169 acres ranging from 15½ to 19 cents per square yard of bed.

The gulch deposits in the western slope of Huntsville mountain have been worked to some extent, and yielded a considerable amount of coarse gold. In a narrow mud seam at the head of one of these gulches a nugget weighing 5 pounds was found.

The crystalline schists at Vein mountain have a general strike of N. 10° to 15° W., dipping 30° N. E. A number of small

[1] By Dr. Chas. Baskerville, assistant chemist of the N. C. Geological Survey. Assay No. 254 of the Survey laboratory series.
[2] By Dr. C. Baskerville. Assay No. 255 of the Survey laboratory series.
[3] By Mr. G. B. Hanna.

pegmatitic (?) dikes cut the country at various angles, with unmistakable signs of faulting.

A series of as many as thirty-three (33) parallel auriferous quartz veins crosses at Vein mountain in a belt not over ¼ mile wide. The principal and largest one of these is the "Nichols" vein, which has been prospected in four shafts, the deepest one being 117 feet. Shaft No. 1 is 1200 feet east of No. 4, and 100 feet above it in elevation. The strike of this vein is about N. 80° E., and its dip varies from 75° N. W. to nearly vertical. Its thickness is reported to vary from a few inches to three (3) feet, the usual portion of the vein worked being from 15 to 30 inches. Below the water level the quartz is mineralized with sulphurets, chiefly pyrite and some chalcopyrite, galena and blende. A number of assays show the following variation in the value of the quartz. :

Assays, Gold Ores, Nichols Vein, Vein Mountain.

	(285)	(286)	(287)	(288)	(289)	(290)	(291)
Gold (per ton)	$2.58	$4.17	$6.20	$10.33	$13.43	$12.40	$70.28
Silver " "	trace.	trace.	trace.	trace.	trace.	1.51	5.43
	$2.58	$4.17	$6.20	$10 33	$13.43	$13.91	$75.71

According to the statement of the present superintendent, Mr. B. G. Gaden, mill runs of the ore have averaged $15 and $17 per ton. If any such values can be obtained in quantity, there is no reason why the mine should not be operated at a great profit, and the present inactivity is difficult to explain. There is a ten stamp mill in good condition, without any concentration machinery, on the property.

RUTHERFORD COUNTY.

The Alta (Monarch or Idler) Mine is situated about 5 miles north of Rutherfordton, on the divide between Cathey's creek and the second Broad river.

As many as thirteen parallel quartz veins have been explored here, within a distance of ½ mile across the strike. The four larger veins are known as the Monarch, Alta, Carson, and Glendale. These various veins have been worked since 1845 by numerous shallow open cuts, pits, and shafts, down to the water

level, and the ore was milled in arrastras. The last work was done on the Alta vein some 2 or 3 years ago. A shaft was sunk here to a depth of 105 feet, but the workings were inaccessible when visited, and the following notes are taken from several outside reports on the property. The strike of the Alta vein is approximately N. 65° E. The thickness of the vein varies from 10 to 22, averaging perhaps 15 inches. The quartz is of a milky variety, mineralized with pyrite and some chalcopyrite. The ore contains from 1 to 20 per cent. of sulphurets, averaging about 5 per cent. One statement gives its average yield in free gold, by mill test, at $10 per ton; another gives $30; and the value of the concentrates has been stated to be $100 per ton. There is a 5 stamp mill, in very poor condition, on the property.

The Ellwood Mine is situated 3 miles N. 20° E. from Rutherfordton and 1½ miles southwest from the Alta mine, on the waters of Cathey creek.

A series of five parallel quartz veins, 100 feet and more apart, was first opened here some 50 years ago. The last work was done in 1893, but barely paid expenses as stated by the present owner, a fact which it is difficult to reconcile with the subsequent statements. At no point have the veins been worked below water level. The country gneisses strike N. 60° W., and dip 25° N. E. The veins strike N. 50° E., and dip 80° N. W. The thickness of the larger veins varies from 10 to 15 inches. The ore is reported to run $5 to $7 per ton in free gold. It shows some sulphurets, pyrite and chalcopyrite. The sulphuretted ore is reported to run $20 per ton.

The Leeds Mine is situated on a quartz vein parallel to and 100 feet north of the Ellwood veins. It has been abandoned many years and is inaccessible.

CONCLUSIONS AND RECOMMENDATIONS AS TO MINING OPERATIONS IN THE SOUTH MT. REGION.

AREAS STILL AVAILABLE FOR MINING.

In the South Mountain region there are considerable areas of placer mining ground still worthy of attention. The operations

of the past, when little capital and machinery were employed, were necessarily confined to such deposits as lay near water, or to which water could easily be brought. There is still a considerable amount of gold in the beds which remained untouched, as well as in those which have been carelessly or or rudely worked over—some of them more than once. Indeed, some of the richest of these deposits have remained unworked on account of the difficulty of bringing a supply of water to their level, being situated considerably above the neighboring streams, or the higher slopes and benches along the foot hills of the mountains. Attention should be directed to operations on a larger and more systematic scale, than has heretofore been generally in vogue in the district; and by this means the ground can also be more thoroughly prospected and the workable channels more accurately located.

IMPROVEMENT IN WORKING METHODS.

The methods of working are susceptible of improvement. Where the gravel is below the grade of the water courses, and this is so frequently the case in the district, the more general application of the hydraulic elevator is advocated.

TREATMENT OF CLAY BALLS—"SLUICE ROBBERS."

A very frequent source of loss and annoyance is occasioned by the formation of clay balls in the sluices, which in rolling pick up fine particles of gold and carry them off. These are the so-called "sluice robbers." The clay is stiff and greasy, and it is almost impossible to break it up into fine mud before it reaches the sluices. In many instances the miners should, by more careful attention with the gravel fork, prevent its entrance into the head of the sluices. Should it be impossible, with all careful precautions, to avoid the formation of these clay balls, it is suggested that they be collected at the end of the sluice, and, either dried and afterwards pulverized and washed, or treated directly in some sort of puddling boxes.

IMPROVEMENT OF WATER CONDUITS.

Concerning the water conduits, considerable distance and grade can in instances be saved by the construction of closed pipe lines

or "siphons" across the gulches and hollows, where trestling and fluming are impracticable. The ditch lines should also be more carefully surveyed and located; thus on the Marion Bullion Company's propeity the present ditch line could be raised perhaps some 50 feet, which would water new mining ground for many years to come. The construction of better reservoirs for impounding the water, where necessary, should also be looked to.

DISPOSITION OF THE TAILINGS.

The question of attaining an adequate grade for carrying off the tailings is of paramount importance. It is often possible to work a hydraulic mine to advantage, but the fall of the stream below may be insufficient for carrying off the debris or tailings, which are almost wholly fine sand and mud.

In instances this may be overcome by straightening the stream, cutting off bends by canals, and by removing such natural obstructions as shoals. By thus cleaning out a stream, portions of its bed gravel may also be made available for washing. Thus a crude survey of the upper part of South Muddy creek has shown that by removing the Taylor shoal the surface of the stream above can be lowered so as to reach the bed rock on the Marion Bullion Company's land.

Another important matter is the disposition of the tailings. Unless there be sufficient current and volume of water the stream will become filled with fine sand, and eventually overflow its banks, depositing the sand and rendering the adjoining bottom lands waste. In the South Mountain region this is very apt to be the case, and as the bottoms are considered the most valuable part of the farming land, the consequence of impairing them may result in serious litigation, as has been the case in California.

The only means of averting this trouble is to devise some artificial dumping ground for the tailings, such as may be attained by the construction of canals and dams.

MONAZITE DEPOSITS IN THIS REGION.

Attention is called to the value of the mineral monazite, which has of late years come into demand for the manufacture of the

incandescent light mantles, as an important product in many of the gold placer mines of this region.

DEEP MINING IN THE SOUTH MOUNTAIN REGION.

Referring to the upper decomposed rock layer with its innumerable auriferous quartz veinlets, a combination sluice and mill treatment by the Georgia method may in many cases be applicable.

But little encouragement can be given to deep mining in the South Mountain region. It is of course impracticable to mine the small quartz veins, so abundant in the region, to any depth. They are too narrow, and not sufficiently rich in gold; nor will they unite in depth, as is the prevalent belief of many. There are a few larger veins, such as the Nichols and the Alta, which would apparently warrant further exploitation. They should be opened below the water level in depth, and for some distance along the strike so as to expose a fair amount and the various grades of ore in sight. Cross-cuts should also be driven so as to determine the proximity of other veins of importance, if there be any. If then, careful and impartial samples be taken for assay, or better still, mill tests be made, the probable value of the mine can soon be established. According to outside reports there are ores here which rank in quality with those of successful operating mines elsewhere. This, however, needs verification; the Survey can make no definite statements in the light of present conditions. Finally, if upon proper investigation, such mines are really proven to contain workable ores, they should be operated under proper business management and technical skill, and with sufficient equipment and working capital to insure their success. The stamp mill, with concentration and chlorination works should be tenaciously adhered to.

DESCRIPTION OF MINES IN OTHER PORTIONS OF THE GENERAL SOUTH MT. BELT.

POLK COUNTY.

The Polk county deposits, some 25 miles southwest, appear to be an extension of the deposits of the South Mountain area. The

gravel of this county is much like that of Burke, McDowell and Rutherford, but the region is lacking in the natural advantages, which, in these latter counties constitute so important a feature in working the deposits; and from this defect, chiefly, the mining has languished. In this county gold occurs in both placers and veins—strikingly similar to the placers and veins in the larger areas just discussed. At present the localities are hardly more than names, for the desultory work carried on cannot be called mining. The better known localities are the Pattie Abrams, Wetherbee, Red Springs, Tom Arms, Splawn, Ponder, Riding, L. A. Mills, Carpenter, Hamilton, Neal, MacIntire, Double Branch and Prince. These all had a good reputation in the palmy days of mining, while the deposits contiguous to water lasted, but at present none can be worked on a large scale without a larger supply of water than can be obtained from the vicinity of the mines.

The eastern part of this county is comparatively flat, and a sufficient supply of water with a good head could be obtained only from the North Pacolet river in the southwest part of the county, by a ditch 20 miles long.

The Prince Mine is exclusively a placer working, and it is not known that veins exist. The better quality of quartz found in the top dirt shows an ounce of gold per ton, by assay.

The Red Spring Mine has 3 veins; and the Splawn mine has a massive vein of low grade quartz.

On the Double Branch Property, some assays of a narrow quartz vein (1 to 3 inches in width) show enormous variations:

Assays, Gold Quartz, Double Branch Mine, Polk County.

	(292)	(293)	(294)	(295)
Gold, per ton	$2.07	$23.77	$465.07	$9.30
Silver, " "	trace.	trace.	1.43	trace.
	$ 2.07	$23.77	$466.50	$ 9.30

292. Barren looking quartz. 293. Lively quartz, with string of brown ore, sampled across vein, 2½ inches.

294. Sampled across vein, 1 inch (Brown Ore). 295. Compact pyrites, covered with coating of brown oxide.

At the Smith Mine, ½ mile east of the above, there are similar rich narrow veins, the occurrence being strikingly like that at the Carolina Queen mine in Burke county.

BURKE COUNTY.

The Brown Mountain Mine is situated 13 miles north of Morganton on Caney branch, a tributary of Upper creek. The main mass of Brown Mt. is made of granite, while its western slope, towards Upper creek, is composed of chloritic schists. The mine openings, which amount simply to prospects, consist of two shafts and one small open cut. Shaft No. 1 is 20 feet deep, in coarse grained granite. The quartz appears to lie in irregular stringers in the granite, varying from 1 to 6 inches in thickness; sulphurets occur sparingly. An open cut, 6 by 15 feet by 5 feet deep, is situated 75 feet southeast of shaft No. 1, and exposes a ledge of granular, milky quartz, 7 feet wide, intercalated with chloritic schist. It has a barren appearance. The dip is 75° S. E.

Shaft No. 2 is situated ¼ mile west of No. 1. It is 25 feet deep, and exposes two bodies of chloritic schist, each about 2 feet in thickness, lying in decomposed granite, and striki g N. 60° W., with a dip of 75° S. W. The most southwesterly one of these is well impregnated with quartz lenses and stringers, and presumably constitutes the ore.

Gen. R. F. Hoke, of Raleigh, N. C., the owner of the property, furnished an assay of a sample, taken from "The shaft on the top of the hill", (presumably shaft No. 2), which showed $15.42 per ton (gold $12.40, silver $3.02). A sample taken from the ore dump at the mouth of this shaft by the present survey, showed only a trace of gold and one ounce of silver.[1]

More extended prospecting is to be recommended here before the value of the deposits can be determined. The bed of Caney branch was washed for gold in former years, up to a point about opposite to shaft No. 1, and is reported to have yielded well.

CALDWELL COUNTY.

The Miller, Scott Hill, Pax Hill and Baker mines are situated on the waters of Johns river near the southern boundary line of the county.

[1]Assay sample No. 268. Dr. Chas. Baskerville, Chemist.

Their respective positions are better shown in the accompanying topographic sketch, fig. 15, taken from the Morganton sheet of the United States Geological Survey. These mines are located on parallel veins, in each instance in close proximity to a wide diabase dike, which strikes across the mica gneiss country in a direction about N. 20° W. None of the mines have been operated for some years past, and they are now entirely inaccessible, wherefore but little can be said of them.

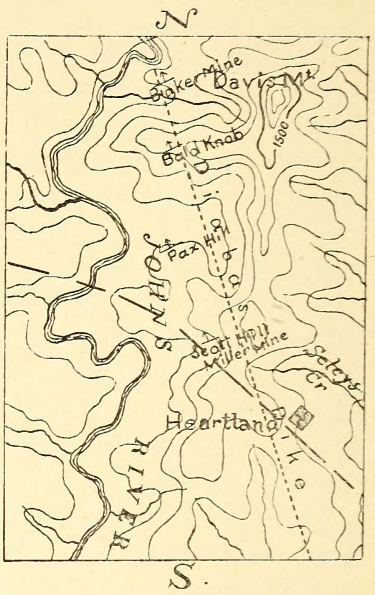


Fig. 15. Topographic map; showing location of Miller, Scott Hill, Pax Hill, and Baker Mines. Scale 1 inch—2 miles. Contour Interval 100 feet.

The Miller and Scott Hill Mines adjoin each other, and are situated on the waters of Seley's creek, 1½ miles northwest of Hartland P. O.

The branches and adjoining hill ground have been worked for placer gold. A series of parallel veins have been explored by a great number of cuts, tunnels and shallow shafts. Judging from the course of these old diggings the strike of the veins is N. 50° —60° E., with a dip to the northwest. The float quartz which was observed here is of a white vitreous variety, and the largest pieces are 12 inches in thickness.

A five stamp mill was at one time in operation at the Miller mine, but it is now converted into a distillery. The diabase dike passes near this building and strikes N. 20° W.; it is probably over 100 feet wide.

The Pax Hill Mine is 1 mile northwest of the Miller and Scott Hill mines. Some placer work has been done here. Three main veins have been opened, situated about 30 yards apart, and striking N. 60° E. They are reported to be respectively 8, 10 and 12 inches wide.

The Baker Mine has been more extensively worked than any of the above mentioned. It is situated on the western slope of Davis mountain, near the river.

The country schists and gneisses strike northeast, and dip southeastward. The diabase dike at this point is very wide (over 75 feet), and is largely altered to serpentine, intersected by narrow veinlets of chrysotile. The quartz veins are in the schist and run northwest and southeast; it is not certainly known whether they continue into and across the serpentine.

There are four principal veins; the more northerly is the Braswell, which has a large boldly projecting outcrop, but has never been much examined. It strikes N. 35° W., and dips about 60° N. E.; its width is from 2 to 5 feet. The Goley Ann vein bears N. 39° W., and dips 70° N. E.; it is narrow at the surface.

The Shaft vein is next, to the southwest; it strikes N. 45° W., and dips 66° to 75° N. E. It is from 20 to 24 inches in width, and has been opened at points 200 yards apart. The quartz veinstone carries scattered galenite and associated minerals.

The Cabin vein is still further south, and was worked at points 100 yards apart; it strikes N. 35° W., dips 60° N. E., and is 20 inches wide. The veinstone is quartz with ferruginous matter and galenite in considerable quantities. The galenite is highly auriferous as well as argentiferous; some assays[1] of the pure material show:

Assays, Ores from Shaft Vein and Cabin Vein, Baker Mine, Caldwell Co.

	Shaft Vein. (296)	Cabin Vein. (297)
Gold, per ton	$ 87.31	$ 34.00
Silver, per ton	21.24	87.89
	$108.55	$121.89
Lead, per cent	84%	83.5%

The quartz of all the veins, aside from the galenite, carries gold. The surface and particularly the gulches and streams were originally rich in placer gold.

Adjoining the Baker is the *Old Miller Mine*, a former placer digging. About ½ mile south of the Baker is the *Bald Knob Mine*, where the vein is reported to have a thickness of 4 feet. The *Francis Mine* is also near here.

[1] By J. G. Ellery.

It is a noteworthy fact that all of the above described mines hold a positive relation to the diabase dike which accompanies them, and which has undoubtedly facilitated the activity and ascension of the ore bearing solutions.

The Bee Mountain Mine is situated about 4 miles (air line) N. 80° W. from Lenoir, on the northeast slope of Bee mountain. The openings consist of two shallow prospect shafts and a tunnel. The country rock is garnetiferous mica gneiss and pegmatite, which strikes N. 60° E., and dips 45° S. E.

Shaft No. 1 is 70 feet deep; now filled with water. The dump shows no ore. Shaft No. 2 is about 30 feet deep, and shows a 4 foot quartz vein on the outcrop, striking N. 75° E. Much of the quartz is cellular and stained brown, and is mineralized with zinc blende and some galena and chalcopyrite.

The tunnel is situated lower down on the slope of the hill, and is 100 feet long in a direction N. 20° W.; it exposes nothing of interest, as it does not cut the vein.

WILKES COUNTY.

At Flint Knob in the southwestern part of the county, 6 miles east of Deep gap in the Blue Ridge, argentiferous lead ore is found. The property is situated on a mountain spur that shoots off from the Blue Ridge at intervals, and extends with gradually diminishing sharpness of outline and altitude to the Yadkin river. This particular spur is called Laurel Spur, and further down, Flint Knob, from the abundance of quartz which covers it. The earliest settlers were aware that lead was found there; extended explorations were undertaken some 60 years ago by Dr. McKenzie, and later by Gen. S. F. Patterson. The galenite is scattered more or less sparingly in a quartz gangue. Assays by Adelberg and Raymond showed samples to contain:

Assays, Ore and Concentrates, Flint Knob, Wilkes County.

Ore. (298).		Concentrates. (299).	
Lead	19.5 per cent.	Gold, per ton	$ 81.57
		Silver, per ton	7.33
			$88.90

Five tons of ore made one ton of concentrates.

When visited in the fall of 1894, the superficial explorations of several quartz veins, carrying galena, pyrite and chalcopyrite, were seen; but at no point had sufficient work been done to determine the possible value of these deposits. The country rock is garnetiferous gneiss.

In the northern part of the county, where the road from Trap Hill to Wilkesboro crosses Roaring river, gold has been washed from the river sands.

Another locality is near Trap Hill, on the eastern face of the Blue Ridge at Bryan's gap, where a bold outcrop of quartz has been traced for nearly three miles; the vein dips easterly with the schists, and ranges from 3 to 20 feet in width; it carries iron pyrites with a small proportion of copper pyrites, and is generally auriferous. A series of assays show:

Assays, Gold Ores, Bryans Gap, Wilkes County.

	(300)	(301)	(302)	(303)	(304)	(305)	(306)
Gold, per ton	$1.57	$1.55	$2.07	$3.10	$4.14	$5.17	$10.29
Silver, per ton	.84	1.01	.59	.91	trace	none	.88
	$ 2.41	$ 2.56	$ 2.66	$ 4.01	$ 4.14	$ 5.17	$ 11.17

CHAPTER VIII.

THE GOLD DEPOSITS WEST OF THE BLUE RIDGE.

In the region west of the Blue Ridge are several gold mining localities, some of which have attracted attention, and have been the site of more or less productive work.

It is highly probable that the schists in the mountain section are universally slightly auriferous, the gold being set free by weathering, and after erosion, being concentrated in favored sinks.

In truth gold has been found in most of the mountain counties, and these sporadic occurrences have given rise to numerous, but short lived, mining excitements.

From a large number of assays of material from all parts of the Blue Ridge counties it may be said that gold is never absent whenever the material possesses the least dissemination of any variety of sulphurets, and generally in quantities somewhat larger than traces, though not often constituting workable ores. The presence of galenite usually adds to the silver contents.

In Ashe and Alleghany counties some of the copper ores contain a small proportion of gold and silver, though, with the exception of the Copper Knob mine, they are not regarded as possible producers of the precious metals.

ASHE COUNTY.

The Copper Knob (or Gap Creek) Mine is situated in the southern part of the county, on the waters of New river. There are three quartz veins, though only one of them has been worked to any extent. It lies in a large body of hornblende schist, but the prevalent country rock of the section is gray gneiss, with a strike N. 60° E., and a dip 40° S. E. The strike of the fissure is N. 35° W., and the dip 45° N. E., though neither dip nor strike is uniform.

The vein-stone is quartz; in the upper part it was accompanied by a selvage of iron peroxide, extraordinarily rich in gold. The mineral seam occupied the centre of the quartz fissure, and varied from 4 to 6 inches in thickness. In the 60 foot level the vein varies from 14 inches to 3 feet. On the northwest course, along this level, the vein contains copper ores for 53 feet, when the quartz becomes slightly changed and carries native gold, with brown oxide of iron, for about 36 feet. Here the bearing is changed to N. 43° W. The vein appears to be more mineralized on the northwest than on the southeast side of the workings, which run into the Knob. The ore is complex: vitreous copper ore, malachite, chryscolla, a very little chalcopyrite, brown ore, etc. Iron pyrite is almost wanting. The ore seam increased somewhat in width as greater depth was gained. The shaft was sunk to a depth of 60 feet with satisfactory results, and subsequently deepened (as reported) to 140 feet. At this stage the mine became the prey of a company of speculators. The concurrent testimony of many persons cognizant of the last work is that the resources of the mine continued good as far as the explorations extended.

The nature of some of the ore is shown in the following assays:

Assays, Gold and Copper Ores, Copper Knob Mine, Ashe County.

	(307)	(308)	(309)	(310)
Gold, per ton	$ 8.62	$ 34.79	$ 57.36	$ 77.51
Silver, " "	2.26	25.50	14.53	45.68
	$ 10.88	$ 60.29	$ 71.89	$ 123.19
Copper, per cent			23.83%	37.44%

In Watauga County a limited area of gold gravel is found on Howard's creek, which was worked on a small scale before the war. Gold is also found in this county at Hardin's, one mile north of Boone.

In Buncombe County, indications of gold have been found on Cane creek.

HENDERSON COUNTY.

The Boylston Mine is situated on the southeastern slope of Forge mountain, on the waters of Boylston creek, 22 miles south of Asheville, and 12 miles west of Hendersonville. It is the

property of the Boylston Mining Company, and embraces an area of some 618 acres. The mine is equipped with a ten stamp mill, Frue vanner, boiler, engine, etc., all of which are now in serious disrepair.

The topography of the region is shown in the accompanying sketch map (Fig. 15), redrawn from the Pisgah topographic atlas sheet of the United States Geological Survey.

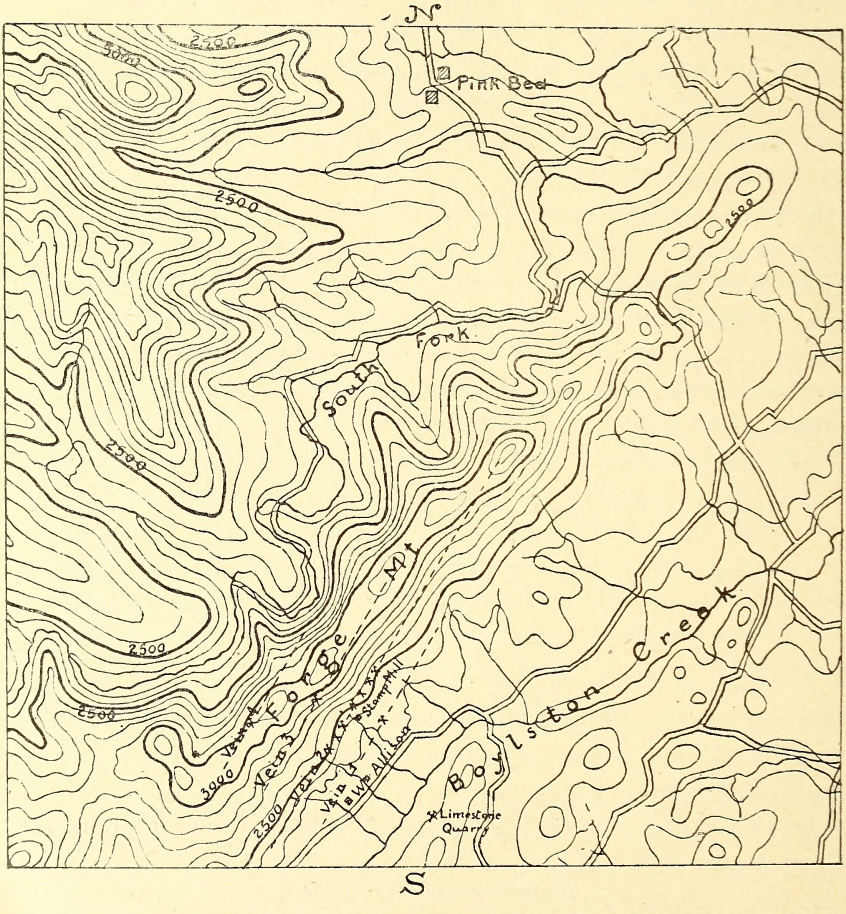


Fig. 16. Topographic map, showing location of the Boylston veins on Forge mountain, Henderson County, N. C.
Scale: 1 inch 1 mile; contour interval 100 feet.

The general elevation of the valley of Boylston creek is 2200

feet above the sea level. The crest of Forge mountain rises 900 feet above the valley, or 3100 feet above sea level.

Forge mountain is made up of fine grained mica and hornblende gneisses and schists, in part much crumpled. The general strike of the schistosity is N. 20° to 30° E. The dip is to the northwest; near the surface the inclination is about 35°, gradually increasing to 50° and 60° within a short distance, and in depth it is reported to be nearly vertical, though still to the northwest. This phenomenon is undoubtedly to be ascribed to the dislocating action of alternate frost and heat, augmented by the action of gravity, especially on hill and mountain slopes.[1]

This anomalous dip also applies to the quartz veins at the Boylston mine, as the fissures follow approximately the cleavage planes of the schists.

The schists are cut by a granite dike, the general strike of which is about N. 30° E., dipping apparently at a steep angle. It is a light colored biotite granite of coarse grain, and is largely decomposed to white, kaolinized masses. The width of this dike was not established, but it appears to be over 100 feet in places, and contains large included fragments of the country schists, showing that the age of its intrusion was subsequent to that of the force which rendered the country schistose.

The valley of Boylston Creek is composed of schistose limestone. Along its northwestern boundary, at the base of Forge mountain, this limestone, according to Dr. Wm. B. Phillips,[2] dips to the southeast and is uncomformably overlaid by the schists of the mountain. The limestone outcrop was observed in Woodfin's quarry on the western slope of a low ridge, skirting the eastern bank of Boylston creek. It strikes N. 40° E., and dips 45° S. E., and is overlaid by crumpled schists, which are in part graphitic. These schists contain interlaminated rusty quartz lenses, from ½ to 2 inches in thickness, which carry traces of gold and silver.[3]

The limestone is of a grey blue color, compact, fine crystalline, and apparently quite free from siliceous matter. Some 4 miles further up the valley it is reported to hold thin veins of quartz

[1]On the action of frost in the arrangement of superficial earthy material. By W. C. Kerr, Am. Jour. Sci., III, Vol. 21, May, 1881.
[2]In a private report on the property.
[3]Assayed by Dr. Chas. Baskerville, assistant chemist N. C. Geological Survey.

carrying pyrite, chalcopyrite, galena and blende, though not in commercial quantities. These rocks of the Boylston valley and Forge mountain are in a narrow belt, lately designated as the Ocoee formation by Mr. Arthur Keith of the U. S. Gelogical Survey.

Four main auriferous quartz veins have been discovered on the Boylston property. They are parallel and strike N. 30° E., dipping to the northwest at angles varying from 25° to 75°, their upper portion or crest being deflected down hill, as already mentioned.

In places the quartz is deeply corrugated, and has a banded structure, as though it were folded like the enclosing schists. At the same time it contains included fragments of the schist, and hence the age of its deposition is later than that of the schistosity. This crumpled, quasi-schistose structure of the quartz must therefore be due to other causes, and the most reasonable one appears to be that during deposition the inside layer, next to the wall of the fissure, was moulded on the crumpled schists, and the next succeeding layer was moulded on the first, and so on, producing casts of each other.

The character of the quartz is usually crypto-crystalline, vitreous, being cellular and stained brown above the water level. Rarely it is fine grained, saccharoidal and milky.

The thickness of the veins varies from 1 to 4½ feet. A pay streak, from 1 to 8 inches wide usually appears along the hanging wall. The quartz carries free gold in the upper levels and free gold and sulphurets (pyrite and some galena) below the water level.

For the convenience of description the veins have been numbered 1, 2, 3, and 4, beginning with the one nearest the eastern base of the mountain.

The occurrence of gold in Boylston creek was known for a long time, but it was not until the winter 1885-1886 that the quartz veins of Forge mountain were prospected by Mr. Wm. Allison. He worked the soft, decomposed outcrop of vein No. 2, by sluicing and washing, with good results. Explorations proved so favorable that the present company was formed in 1886, and

machinery was erected for treating the ores. The mine was then operated spasmodically and with varying success. In the fall of 1889, Dr. Wm. B. Phillips made a thorough examination of the property, with practical mill tests of the ores, the results of which were presented in a report to the company.

The mine is now idle and at the time when visited by the Survey (October, 1894), most of the openings were caved in and inaccessible. Much of the matter, including assays, contained in the following description of the Boylston mine, has been taken from the detailed report of Dr. Phillips.

Vein No. 1 is exposed in a small pit, now caved in, near the eastern base of Forge mountain. Its width at this point is stated to be 2½ feet, with a 2½ inch seam of slaty material. The quartz is saccharoidal and stained brown. An assay, representing the width of the vein, excluding the slaty seam, shows:

Assay, Gold Ores, Vein No. 1, *Boylston Mine, Henderson County.*

	(311)
Gold, per ton	$4.13
Silver, "	50
	$4.63

On the Frank Sitton land, adjoining the Boylston property on the northeast, the same vein has been explored in a shaft 30 feet deep, and an open-cut 25 by 5 by 5 feet. The thickness of the vein is reported to be 3 feet. Two assays show:

Assays, Gold Ore, Boylston Vein No. 1, *Sitton Property, Henderson County.*

	(312)	(313)
Gold, per ton	$ 13.37	$13.44
Silver, per ton	.41	.60
	$ 13.78	$14.04

Vein No. 2 has been more thoroughly prospected and developed than the others. All of the ore that has been mined and milled at the Boylston was obtained from this vein.

The principal work on No. 2 begins at the George Sitton branch (Allison opening), and extends thence in a northeasterly direction along the outcrop in a series of open cuts made at intervals over a length of about 1500 feet, to the Mill branch, and thence in a series of drifts, for a distance of 300 feet.

The Allison opening extends from the George Sitton to Rail Cove branch, a distance of about 600 feet. It is an open cut,

averaging 10 feet in width and 15 feet in depth. In this distance are situated two shafts and an inclined tunnel, namely the Garwood and Radford shafts, and the Allen slope. In the open cut the vein is from 3 to 4 feet thick, composed of decomposed sulphurets and sugary quartz. A rich pay-streak of reddish brown quartz forms a layer, from 1 to 3 inches thick, next to the hanging wall, generally; but it is not to be depended on as regards either thickness or linear extent. In the sulphurets, composed chiefly of pyrite and some little chalcopyrite, about one-third of the gold is free.

The Garwood shaft is 25 feet deep, and the thickness of the vein here is stated to be 4½ feet. At the bottom of the shaft the Thomas level extends 35 feet, S. 15° W.

The Allen slope is 25 feet long. The Radford shaft is 20 feet deep; the vein is 3 feet thick, and dips 65° N. W. The granite dike appears in the hanging wall, 4 feet from the vein.

A number of assays show:

Assays, Gold Ores, Vein No. 2, Allison Opening, Boylston Mine, Henderson County.

	(314)	(315)	(316)	(317)	(318)	(319)	(320)	(321)	(322)
Gold, per ton	$7.23	$4.13	$4.13	$5.18	$6.20	$7.23	$109.35	$84 75	$7 23
Silver, per ton	.41	.41	.50	.50	.65	.50	4.04	3.87	.75
	$7.64	$4.54	$4.63	$5.68	$6.85	$7.73	$113.39	$88.62	$7.98

314. Quartz from open cut. 315. Sulphurets from Allen slope. 316. Sugary quarz from open cut. 317. Ore from mill dump. 318. Ore from mill dump, one-half Garwood shaft. 319. Quartz from Garwood shaft. 320 and 321. Reddish brown ore from pay streak. 322. Outcrop of sulphurets in branch.

Dr. Phillips estimates that 1,000 tons of ore have have been taken from this part of the mine—between the Geo. Sitton and Rail Cove branches—and that the amount of ore still remaining above the water level is about 2000 tons, which may be depended on to yield $4.00 per ton in free gold (assay value). He gives as the cost of mining, transportation and milling, $2.25 per ton.

The Winny Dunkin opening begins on the north side of Rail Cove branch, and extends as an open cut N. 15° E., for a distance of 275 feet. It is 10 to 15 feet in width, and about the same in depth. Sulphurets appear here 20 feet from the surface. In the zone above the sulphurets the vein matter is composed of granular quartz, decomposed sulphurets, slate with seams of quartz, and segregated thin seams of rusty quartz, carrying coarse gold. A section from foot to hanging walls, 10 feet below the surface, is given as follows:

	Feet.	Inches.
Rusty brown slate, with seams of quartz	0	6
Rusty quartz, carrying coarse gold	1	0
Milky quartz, somewhat cellular and rusty	1	6
Thin bands of brown slate, highly silicified	1	6
	4	6

Some assays from the Dunkin opening show :

Assays, Gold Ores, Vein No. 2, Dunkin Opening, Boylston Mine, Henderson County.

	(323)	(324)
Gold, per ton	$ 4.13	$ 4 13
Silver, per ton	5.48	.50
	$ 9.61	$ 4.63

322. Sulphurets; the high silver is due to the galena present. 323. Ore from cut, 15 feet below the surface, sampled across the vein from wall to wall.

It is estimated that 300 tons of ore were removed from this opening, and that the amount of free milling ore still remaining above the water level between Rail Cove and Mill branches is 4100 tons, which will yield $4.00 per ton, (assay value.)

Immediately on the north side of Mill branch is a series of seven drifts, now in very bad condition, along the outcrop of vein No. 2, for a distance of 300 feet.

Their relative positions are shown in fig. 17.

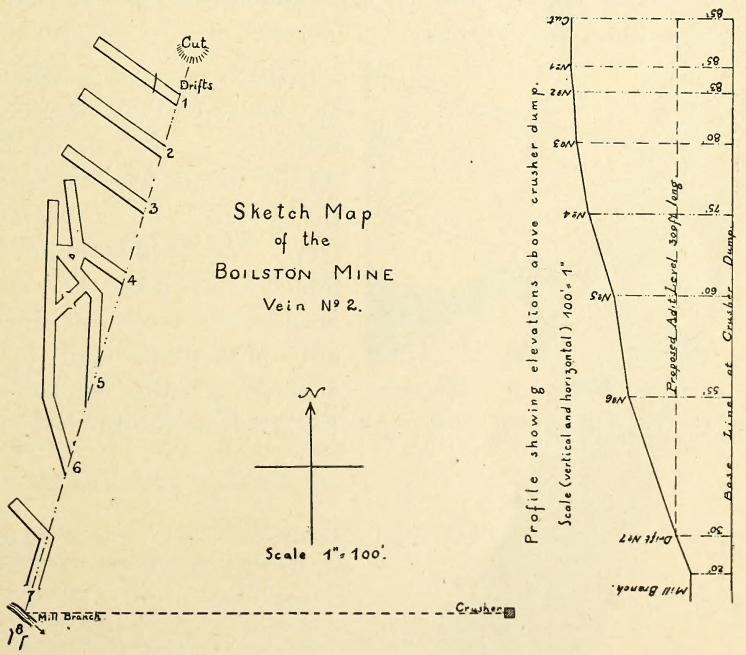


FIG. 17 Drifts 1 to 8 inclusive, Vein No. 2, Boylston Mine.

On the south side of the branch is drift No. 8, 50 feet long. The granite dike was penetrated by it, and the thickness of the quartz vein is 3 feet. An assay shows.

Assay, Gold Ore, Drift No. 8, Boylston Mine, Henderson County.

(325)

Gold, per ton	$ 4.13
Silver, per ton	.40
	$ 4.53

Drift No. 7 follows the pay streak, which is 3 to 6 inches thick, along the hanging. The width of the vein is 4 feet, filled with stained granular quartz. It is accompanied by the granite dike. An assay shows:

Assay, Gold Ore, Drift No. 7, Boylston Mine, Henderson County.

(326)

Gold, per ton	$23.77
Silver, per ton	1.70
	$25.47

It is estimated that 60 tons of ore have been removed from here.

Drift No. 6 joins No. 5 by a cross cut. It shows 2 feet of sugary quartz, stained brown. The amount of ore removed from here is estimated at 60 tons.

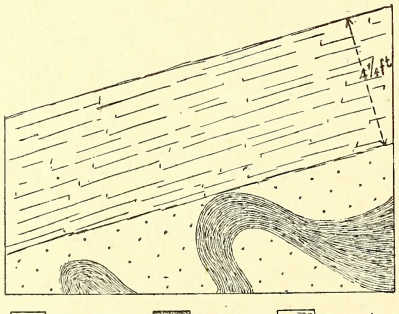


Fig. 18. Section on the dip of the vein at mouth of Drift No. 5. (See also fig. 17, p. 187.)

Drift No. 5 opens on a platform at the top of an incline, 200 feet long, to the crusher dump. At its mouth the thickness of the quartz vein measured 4¼ feet. The highly crumpled and folded schists make their appearance on the foot wall side, and are broken through by the eruptive granite, as shown in Fig. 18, from the Boylston mine.

Drift No. 4 exposes on the outcrop 4 feet of quartz, separated by 1 foot of granite. The vein swells and pinches, and appears to be cut off at one point by the crumpled schist. Near the face of the opening the vein matter consists of the schist itself, highly impregnated with quartz stringers and stained brown. This is best illustrated in Fig. 19.

It is estimated that 50 tons have been removed from here.

Drift No. 3: The vein is probably 3 feet thick and dips 25° N. W. About 10 tons of ore have been removed.

Drifts Nos. 1 and 2 show up similarly to No. 3. About 10 tons of ore have been removed from each.

Some 20 feet beyond the mouth of Drift No. 1 is the face of the Upper Cut, the termination of the work that has been done on this part of vein No. 2. It is on this ridge that the vein appears to have been most disturbed by the granite dike, which lies next to the foot wall, and carries some free gold. An assay of the three feet adjoining the foot wall shows:

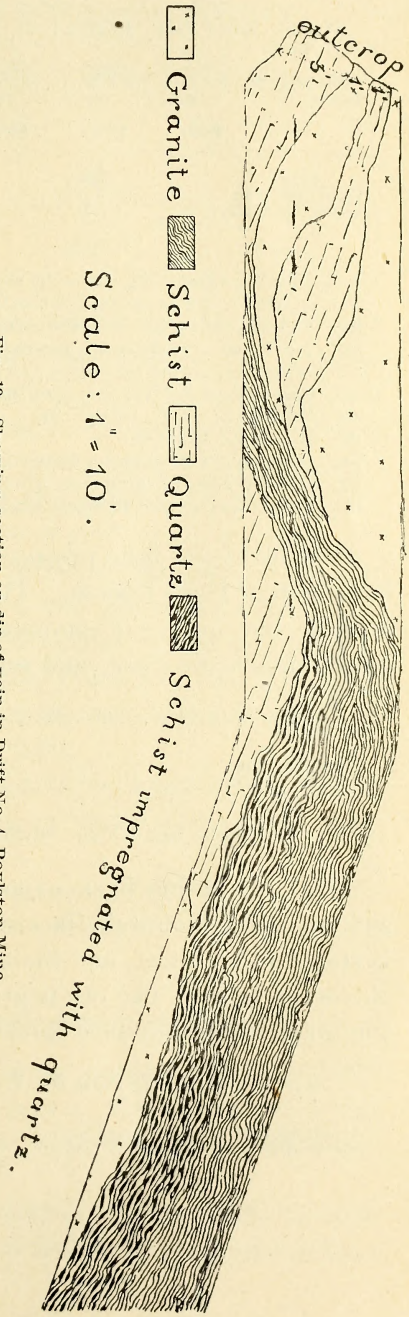


Fig. 19. Showing section on dip of vein in Drift No. 4, Boylston Mine.

Assay, Gold Ore, Vein No. 2, Boylston Mine, Henderson County.

	(327)
Gold, per ton	$ 2.06
Silver, per ton	.50
	$ 2.56

Some assays of the ore from these drifts show:

Assays, Gold Ore, Drifts 1—7, *Boylston Mine, Henderson County.*

	(328)	(329)	(330)	(331)	(332)	(333)	(334)
Gold per ton,	$ 8.47	$ 8.27	$18.09	$55.30	$ 4.13	$ 5.17	$ 5.18
Silver "	.62	.50	1.01	3.44	.50	.41	.41
	$9.09	$8.77	$19.10	$58.74	$4.63	$5.58	$5.59

	(335)	(336)	(337)	(338)
Gold, per ton	$ 6.20	$ 6.20	$ 4.13	$ 11.37
Silver, per ton	.50	.32	.50	.58
	$ 6.70	$ 6.52	$ 4.63	$ 11.95

Assay No. 328, Sample was taken from pay streak, 8 inches wide, from drift No. 1.
Sample 329, From 8 inches of soft ore, immediately above the pay streak in drift No. 1.
330. Reddish brown pay streak, 8 inches wide, in drift No. 2.
331. Pay streak, 6 inches wide, in drift No. 3.
332. Sample across the face of 3½ foot vein, drift No. 3.
333. Quartzose slate, 12 inches thick, drift No. 3.
334. Mill dump, ⅔ soft, ⅓ hard ore.
335. Mill dump, soft ore.
336. Mill dump, soft ore from above mill.
337. Isolated mass of sulphurets in drift No. 3.
338. From outcrop, 2½ feet thick, where vein No. 2 crosses high top of Forge mountain.

Vein No. 3 has been prospected in a small pit and drift near the head of Rail Cove branch. The thickness is stated to be 2½ feet, and the vein matter is composed of granular quartz, rusty cellular quartz, quartzose slate, and some pyrite. Several assays show:

Assays, Gold Ores, Vein No. 3, *Boylston Mine, Henderson County.*

	(339)	(340)
Gold, per ton	$ 18.60	$ 34.11
Silver, per ton	.32	.82
	$ 18.92	$ 34.93

339. Sampled across face of vein. 340. Six inch seam of rusty quartz.

Vein No. 4 has been exposed on Vineyard branch, near the summit of the mountain, in a small pit, 6 feet deep. Its thickness is stated to be 3 feet, and the strike and dip are similar to those of the other veins. The ore is granular quartz. An assay of a sample taken across the face shows:

Assay, Gold Ore, Vein No. 4, *Boylston Mine, Henderson County.*

	(341)
Gold, per ton	$ 3.10
Silver, per ton	.56
	$ 3.66

A summary statement of the work done by Dr. Phillips in September, 1889, including mining and milling, is as follows:

	Allison Opening.	Winney Dunkin Opening.	Drifts 1. 2 and 3.
No. of tons mined.....	10	25	40
Assay value.....	$5 56	$4.51	$5.49
Cost of mining and transportation.....	$1.50	$1.25	$1.17

The total amount of ore mined and milled was 75 tons, worth $387.95, calculated from the above statement. The amount recovered was $112.20, an extraction of 24.63 per cent. of the assay value. This low yield was in general measure due to the condition of the machinery and outside battery plates; the 75 tons required 348 hours for running through, and during the last 72 hours one-third of the total amount of gold saved, was obtained, although the assay value of the ore remained the same. In other words, 20.8 per cent. of the time gave 33.3 per cent. of the gold, *after* the mill had been brought up to something like its proper efficiency. The rate of milling per day (24 hours) was 5.17 tons; no more than this could be treated owing to the condition of the crusher, the shoes and dies, and the belts.

The mill, if in proper condition, should be capable of treating at least 10 tons per day, with a saving of 60 per cent. of the assay value.

Excluding the interest on the investment, Dr. Phillips estimates the cost of mining, transportation and milling at $2.33 per ton, on a basis of 375 tons per month.

JACKSON, TRANSYLVANIA AND MACON COUNTIES.

The gold of Jackson county has been obtained almost entirely from placers or detrital beds. These are situated chiefly along the southern slopes of the Blue Ridge, near Hogback and Chimney Top mountains.

The most important locality is Fairfield valley, where Georgetown creek, one of the head streams of the Toxaway, is said to have

yielded between two and three hundred thousand dollars. The deposits extend for several miles along these elevated basins, and have been by no means exhausted. The origin of the gold here is doubtless to be sought in the quartz veins of the Blue Ridge, which rises on the north and east—a precipitous wall of gray gneiss—to a height of 700 or 800 feet above the valley. It is along the base of this wall, where Georgetown creek has cut a deep channel, that the gold has been principally obtained.

The deposits in Transylvania county, east of the Blue Ridge, on the headwaters of the French Broad, will probably be found to have a similar origin, and are evidently a continuation of the same belt of deposits.

In the southeast corner of Macon county, in Whitener's valley and Horse cove, mining for gold has been carried on to a limited extent in the stream deposits.

CHEROKEE COUNTY.

Possibly twenty-five to fifty men may be employed in actual mining operations in this county, working some half a dozen placers.

The gold obtained is mostly in the form of large grains and nuggets. The greater part thus far won appears to have come from the valleys of Valley river and its transverse tributary streams. The immediate source of this gold is four fold: (1) The gravel underlying the broad bottoms of Valley river and other streams; (2) The schists and the included quartz stringers or veins of the more elevated country bordering these valleys. (3) The iron ore beds, which skirt Valley river along its whole length, and occur with several reduplications or foldings at intervals for several miles to the east;[1] (4) The limestone (marble), which is usually closely associated with the iron ore beds, and contains gold in connection with galenite and possibly also in quartz veins, that traverse it.

These rocks have lately been referred to the Ocoee by the U. S. Geological Survey.

[1] For an account of these ore beds, see Bulletin No. 1, Geological Survey of N. C.: The Iron Ores of North Carolina, p. 196 et. seq.

The placer mines now worked are situated in the drift which covers the spurs and terminal ridges, especially where they project into the bottom land. Ditches are constructed to bring the water from the upper reaches of the mountain streams, under a sufficient head to operate at the desired points. The drift beds have a depth of 10 to 20 feet, and are occasionally at a considerable elevation above the river.

The schists have not been largely prospected, and cannot be utilized without heavy stamping machinery, as, owing to the steepness of the hills and mountains all the soft and altered material has been cleaned off by denudation. The unaltered schists are more costly to mine and treat, and would require the closest and most economical management; there is abundant evidence, however, that considerable work of this nature has been done on the hill and mountain sides. There are no data in possession of the survey defining the width and extent of the gold bearing schists, nor the number of such zones.

The iron ore (limonite) beds have not hitherto been regarded generally as gold bearing, but some examinations point to a presumption that they are frequently auriferous. Assays of a number of samples ran from $1.86 to $10.60 per ton. The possibilities in this direction deserve further examination.

Gold also occurs in the marble in association with galenite. Such localities are: Section No. 6, 1 mile northeast from Murphy; at Axel's shaft near Marble creek, 3½ miles northeast of Murphy; and near Marble post office.

Some samples of the ores from Section No. 6 gave the following assay values:

Assays, Gold Ores, Section No. 6, Cherokee County.

	(342)	(343)	(344)
Gold, per ton	$ 7.03	$ 13.02	$ 14.88
Silver, "	trace	10	19.20
	$7.03	$13.12	$34.08

So little attention has been given to these occurrences that the extent of the resources is practically unknown, but they certainly appear to be worthy of more thorough exploration.

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ERRATA.

Page 26, first line, also in 30th line "Sturgess" should read "Sturges."

Page 48, twenty-second line, read "favorable" in place of "favorble."

Page 52, second line from bottom, "course" instead of "conrse."

Page 53, fourth line from top, period (.) instead of comma (,) after "seams."

Page 55, first line, new paragraph should begin with: "In the northwestern."

Page 55, ninth line, read "leased" instead of "land."

Page 58, first line, read "sulphurets" instead of "suiphurets."

Page 58, in assay No. 22, the total should read "$3.13" in place of "$3.10."

Page 61, sixteenth line from top, "known" instead of "know."

Page 64, sixteenth line, the semicolon (;) should be a colon (:).

Page 68, tenth line from bottom, "data" instead of "deta."

Page 72, fourth line from bottom, read "surface" instead of "surfice."

Page 74, sixteenth line from bottom, "ef" should be "of."

Page 75, first line, after "$\frac{1}{8}$" read "inch."

Page 77, twenty-first line from bottom, "Uharrie" should be "Uharie."

Page 85, bottom line, "Stanley" should be "Stanly."

Page 93, sixth line from top, "branches" should be "bunches."

Page 94, fifteenth line, for "examination" read "examinations."

Page 101, the scale should be "$\frac{2}{3}$ inch=1 mile" not "3 inches=1 mile."

Page 102, sixteenth line from top, "the" should be "the."

Page 110, twelfth line, read "eastern" in place of "western."

Page 122, sixteenth line from bottom "exstraction" should be "extraction."

Page 129, assay No. 166, should be read "$27.70" instead of "$28.70."

Page 130, assay No. 180 should read "$56.89" instead of "$56.87."

Page 130, third line from bottom, instead of "concentrates" read "concentrated."

Page 131, fifteenth line from top, "indicate" should be "indicates."

Page 131, assay No. 196, the total should be "$5.56" in place of "$5.46."

Page 138, the copper listed under assay No. 216 belongs under No. 215.

Page 142, the copper listed under assay No. 243 should be under No. 244.

Page 165, fifth line from bottom, read "obtained" instead of "obtainded."

Page 171, fifth line, "or" is repeated unnecessarily.



From "Good Roads."

McAdamized Road in Normandy, France.

THE BEST AND CHEAPEST PERMANENT ROAD FOR GENERAL USE.

NORTH CAROLINA GEOLOGICAL SURVEY.

J. A. HOLMES, STATE GEOLOGIST.

BULLETIN No. 4.

ROAD MATERIALS AND ROAD CONSTRUCTION IN NORTH CAROLINA;

BY

J. A. HOLMES, STATE GEOLOGIST,

AND

WM. CAIN, CIVIL ENGINEER.

RALEIGH:

JOSEPHUS DANIELS, STATE PRINTER AND BINDER.

Presses of Edwards & Broughton.

1893.

N 5-5-4
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STATE GEOLOGIST.

J. A. Holmes, ...	Raleigh.

North Carolina Geological Survey,
Raleigh, N. C., January 10, 1893.

To His Excellency Hon. Thomas M. Holt,
Governor of North Carolina.

Sir:—I have the honor to submit herewith for publication as Bulletin No. 4 of the Geological Survey, a brief report on the character and distribution in North Carolina of materials suitable for the construction of highways and public roads; to which has been added a short discussion of the methods of using these materials, and of the tools and machinery used in modern road construction. And I beg leave to express my appreciation of the fact that the subject of better roads is one in which for many years you have shown an active and intelligent interest.

With great respect, I have the honor to be, sir,

Yours obediently,
J. A. HOLMES,
State Geologist.

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PREFACE.

It was originally intended that the notes on the character and distribution in the State of materials suitable for road construction given in this paper, should be published in the Bulletin on Building Stone.[1] But as they are intended for a different class of readers, it is thought best to publish them separately. And as there is at the present time a considerable amount of interest shown in relation to the subject of better public roads, it is thought best to supplement these notes on road materials by a brief discussion of the general subject of road improvement. Two chapters on this latter subject: Chapter III on Methods of Road Construction, and Chapter IV on the Machinery Used in Road Construction, have been prepared by Prof. Wm. Cain, of the State University, who is an engineer of large experience, and is familiar with the needs of the State in this direction.

It is not expected that this short paper will serve to any extent the purpose of a guide to road construction, but it is hoped that it may aid in stimulating a deeper and more intelligent interest in the subject among the people of the State, and may aid in bringing about a system of public roads more in accord with our civilization, with the needs of the community, and with common sense.

Those who wish to go more deeply into the subject of better public roads, and it is hoped that there may be many such, are advised to read, amongst the excellent books published recently, "Highway Construction,"[2] and "A Move for Better Roads,"[3] both of which give lists of numerous other books and pamphlets relating to this subject. And every person interested should read "Good Roads,"[4] the monthly journal published by the League of American Wheelmen, New York.

In the preparation of this Bulletin I have drawn freely from each of these publications, and have endeavored to give full credit at the proper places. I am especially indebted to Mr. I. B. Potter, editor of "Good Roads," who kindly had prepared for me electrotypes from a number of illustrations published originally in that journal.

J. A. Holmes,
State Geologist.

1. Bulletin No. 2 on the Building Stone in North Carolina; by J. A. Holmes and J. V. Lewis, 1893.
2. "Highway Construction," by Austin T. Byrne, pp. 686. John Wiley & Sons, 1892. Price $5.
3. "A Move for Better Roads; Essays on Road-making and Maintenance and Road Laws." Henry Cary Baird & Co., Philadelphia. Price $2.
4. "Good Roads," a monthly journal, edited by Isaac B. Potter, Potter Building, New York $2 a year.

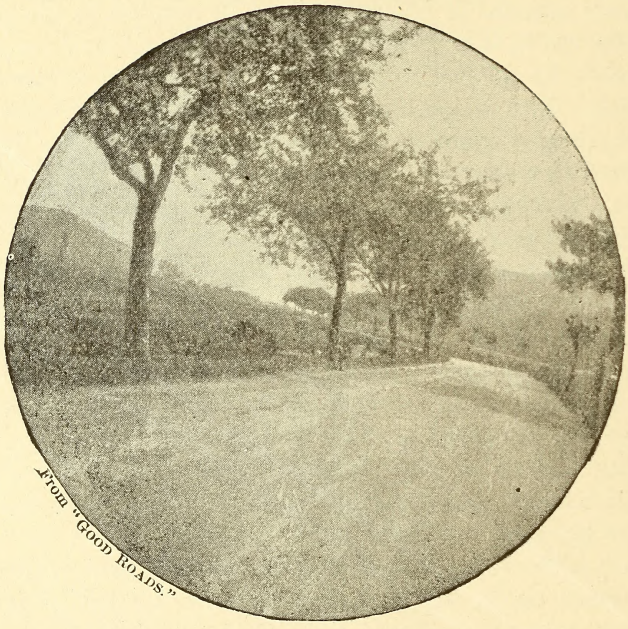


Fig. 1.—A COUNTRY ROAD IN FRANCE. A STONE-PAVED ROAD, THE BEST ROAD FOR GENERAL USE.

INTRODUCTION.

Historical Notes.—The use of stone in the construction of public highways, to the importance of which the American people are at last awakening, is by no means a modern invention. The Babylonians, the Carthaginians, the early Greeks in the Old World, and Incas of Peru in the New World recognized its importance, and some of their paved roads are well known in history, and their remnants still to be seen. And the Romans, starting with the Appian Way (312 B. C.) constructed a series of paved roads from Rome to the principal towns of the Empire and through many parts of Europe. Some of these splendid roads are still in use, and others form the foundations of modern roads.

It was not, however, until the close of the last century that modern European nations became aroused to the necessity of better roads. France and England took the lead in the matter, and soon to be followed by Germany, Switzerland and other countries; each recognizing the fact that good roads are an essential accompaniment and promoter of civilization, national prosperity, and even national existence. The progress in this direction has been constant, until at the present time France alone has not less than 130,000 miles of paved roads, unsurpassed in their excellence by those of any other country. And there is no doubt much of truth in the suggestion that the prosperity of her people, even under adverse circumstances, is due in no small degree to the fact that on her splendidly maintained system of highways the obstacles, the "movement of persons and exchange of commodities" have been reduced to a minimum.

In the introduction to his recent book on "Highway Construction," page 31, Byrne gives the following reasons why public roads have not improved as have other institutions in the United States: "(1) The excellence of the railroad systems and waterways; (2) the indifference of those in charge of highway maintenance; (3) the want of appreciation of the benefits of good roads and the fear of increased taxation on the part of the rural population; (4) the dispersion of the people over large areas in their search for desirable localities for residence; and (5) the ill effects of the system requiring the personal service of the rural population on the highways."

Various States of the Union adopted from the old English laws the provision that every citizen may work out his road-tax on the public highways, and by the continued existence of this law, the American road is now a hundred years behind the demands of American civilization.

Early in the present century North Carolina statesmen, led by Judge Murphy and President Caldwell devoted a large share of attention to the subject of internal improvements. It was their purpose to improve the facilities for navigation on all the principal rivers, and starting from the head of navigation on each stream to construct a series of public highways extending westward into the interior of the State.

In 1823 the Engineer of the Board, Hamilton Fulton, surveyed such a road from Fayetteville to Wilkesboro, and recommended its construction, at a total cost of $63,200; and in his report of this survey he suggests the adoption of the following system of public roads,* dividing them into three classes: The great principal and leading roads in one class to be denominated State roads; another of minor importance into county roads, and a third into private roads. The first of these to be made from a fund of which the State will contribute one moiety, and the counties through which the road passes their respective moities of the expenses actually incurred in the county; when the road is once completed, to be kept in repair by the county. The second class to be made and kept in repair by the counties; and the third to be made and kept in repair by the private individuals who are benefited by the same.

The public highway from Fayetteville to Wilkesboro was never built, as recommended by Mr. Fulton, but the plan bore fruit many years later when, in 1849, the citizens of Fayetteville (at the head of navigation on the Cape Fear river), with the co-operation of the State, undertook the construction of a series of plank roads. The Fayetteville and Western plank road, begun in 1849–'50, was built from Fayetteville to Salem. The Fayetteville and Centre plank road, begun in 1855, was to extend to Centre (now Norwood), in Stanly County. The Fayetteville and Warsaw plank road, also begun in 1855, was to extend eastward to Warsaw, on the Wilmington and Weldon Railroad. The construction of these plank roads was under the management of stock companies, three-fifths of the stock having been subscribed by the State and two-fifths by the citizens of the community. The average cost per mile on the Fayetteville and Western plank road was about $1,300, and on the others it was probably the same.† During a few years after their construction these roads were highly satisfac-

*Annual Report of the Board of Internal Improvements of North Carolina, 1823, p. 45.

†The Fayetteville and Centre, and the Fayetteville and Warsaw roads were never completed.

tory, but it was not long before the timber began to decay; and as the total receipts were not sufficient to make the investment a profitable one, they were not repaired, and have long since disappeared, and are now known only in the memories of older citizens and in the public records, which show them to have cost not less than three hundred thousand dollars.

As early as 1819,* and at intervals for forty years thereafter, the Board of Internal Improvements, as authorized by the General Assembly, co-operated on a small scale in having roads surveyed and constructed in several of the sparsely settled mountain counties; and in 1849–'50 the General Assembly authorized a careful survey of the route, and the construction of the Western Turnpike Road, with various branches, to extend from Salisbury *via* Asheville, through Cherokee County to the State line, the cost to be borne out of funds arising from the sales of the Cherokee lands, and funds raised by private companies along the route. That part of the route between Salisbury and Asheville was abandoned in favor of the Western North Carolina Railroad. The road, with its tributary branches, was constructed from Asheville to its south-west terminus between 1850 and 1859.

All these western turnpike roads, in the building of which the State aided, were, at best, fairly good dirt roads. Instead of constructing permanent stone roads, one of the chief aims of the builders was to get the stone out of the way. Nearly, if not quite all of them, were managed as toll-roads for several years after completion, but this feature has been generally abandoned, to the detriment of the traveller. They are still known as State roads, though the State has long since ceased to be interested in them, financially or otherwise.

During the past several decades plans for public improvement have turned in other directions. The railroads have penetrated many parts of the State; they have absorbed a considerable share of public attention; and there has been a growing belief among the people that they have in a large measure done away with the need for other public highways. But we are just now coming to a clearer understanding of the true relations existing between the railroads and good wagon roads. Both are so essential that we need not stop to compare their relative importance; neither can be extended so as to take the place of the other. It is true that railroads have in large measure done away with the need for long turnpikes extending parallel to them through the same territory, but they have enhanced the importance of other public roads extending out on both sides of the railroad by

* Annual Report Board of Internal Improvements in North Carolina, 1823. pp. 12 and 13.

greatly increasing the service that these public roads may render in the exchange of commodities and in the development of the natural resources of the country. A railroad at every man's door is out of the question; but every citizen should be within easy reach, over a good public highway, of the railroad, the county seat, and the nearest market town. And he is, in an important sense and during a considerable part of the year, nearer to these when separated from them by ten miles of good macadam road than when separated by two miles of a winter-time dirt road.

Some Conclusions.—I have introduced these brief historical notes to show: first, that other civilized countries have now a system of stone-paved public roads, and find them an indispensable adjunct of national prosperity and progress; and, second, that in North Carolina the public road system, if indeed it may be called a system, of the present century has been an expensive failure. It would be an easy task to show also that our lack of good roads has greatly retarded the material growth and development of the State; and that it is a matter of paramount importance that we lose no time in adopting some different system of road construction and maintenance, such as has been found satisfactory in other countries.

So much for the past. The problem of better public roads, especially in the midland and western counties, perhaps outranks in importance all other industrial questions now before the people of the State. The most difficult part of the problem, as is so often the case, is that of revenue—how to raise the funds. This part of the problem demands the consideration of the General Assembly rather than the Geological Survey; but I venture to state in conclusion a few general propositions which have served as a basis of road improvement in other countries, and which I believe must be recognized in establishing a new system of public roads in North Carolina.

1. All public roads should be constructed and kept in repair as far as possible by men employed and trained for this special work; and if it is not deemed wise to abolish at once, as has been done in every other enlightened country, the present system of having every voting citizen liable for work on the public roads, then it will be best to adopt such a modification of it as has been done in Mecklenburg county, where citizens are liable for four days of work, and are relieved of this obligation on the payment of the sum of fifty cents per day. The amount of this substitute money should be small—not greater than fifty cents per day—so that the great majority would pay it rather than work on the roads; and the few who prefer to work may be called out, not in a body, but individually at the discretion of

the road supervisor, and thus forced to labor continuously and intelligently.

2. The cost of the construction of public roads should be paid out of funds raised by either of the following methods:

(a) A State tax or a County tax, or both;

(b) The issuance of State bonds or County bonds, or both.

The latter method possesses one decided advantage in that it provides a large sum for immediate expenditure in the construction of roads, and the existence of these improved roads will so enhance the value of property as to more than pay the interest on the bonds issued, a fact which has been demonstrated by actual experience in Virginia, New Jersey, Connecticut, Indiana, and in other countries. And it possesses a second advantage that the people begin at once to realize the advantages of good roads.

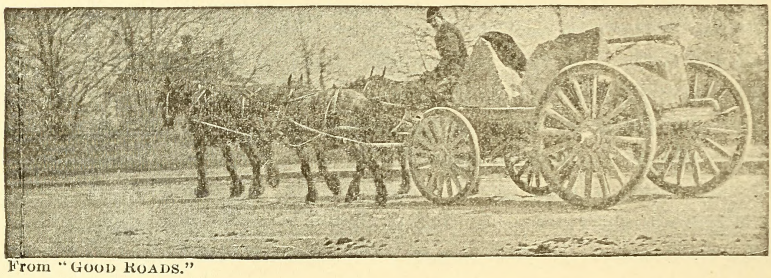
3. All criminals should, so far as possible, be used for work on the public roads, and thereby benefit the communities which have been injured by the commission of crime.

4. While it may be best under our form of government for the several counties to bear the main burden of constructing and maintaining good roads, yet in a work of such paramount importance to every citizen and far-reaching in its consequences, where so large an expenditure is required demanding intelligent supervision, the State should co-operate with the counties in the construction of the principal highways, as it has done in educational matters, in the construction of railroads, canals and other internal improvements. If in no other way the State should co-operate with the counties to the extent (1) of allowing the use of convicts in such counties or groups of counties as agree to raise funds sufficient for the construction of better roads; and (2) by providing for the employment of a practical engineer of roads who can visit the various counties, give intelligent advice and direction to the work, and thus aid in the production of uniformly good results.

5. In the several counties the construction of better roads should begin at the county seats, and the work be done on all the prominent roads radiating out from that point, first near the town, and gradually at greater distances out; except that where several counties co-operate in the construction of a trunk road, extending through them, it may be wise first to complete the work on this road, and construct the other county roads thereafter.

6. While the granite block pavement is probably the best for city streets, and the plank road is perhaps the most economical temporary

road which can be constructed in sandy and well timbered regions, the experience of a century has demonstrated the fact that for the public highways of the country the broken stone covering as used by MacAdam and Telford is by far the most satisfactory, and in the long run by far the most economical.



From "Good Roads."

Fig. 5.—HEAVY LOAD OF STONE BEING HAULED ON A MACADAM ROAD. IT SHOULD BE OBSERVED THAT THE WHEELS DO NOT SINK INTO THE SURFACE, AND THAT CONSEQUENTLY THE LOAD WHICH CAN BE HAULED IS GREATLY INCREASED.

CHAPTER ONE.

CHARACTER AND DISTRIBUTION OF ROAD MATERIAL.

In the following discussion of the character and distribution of road material in the State, it is thought best to avoid the use of technical terms as far as possible; and the names of rocks here used are those applied by the engineer rather than by the geologist. The character of the materials are discussed with a view to their fitness for use in the construction of broken stone pavement as used by Macadam and Telford on the public highways.

CHARACTER OF ROAD MATERIAL.

"In considering the relative fitness of the various materials," says Byrne.* "the following physical and chemical qualities must be sought for:

"(1) Hardness, or that disposition of a solid which renders it difficult to displace its parts among themselves.

"(2) Toughness, or that quality which will endure light but rapid blows without breaking.

"(3) Ability to withstand the destructive action of the weather, and probably some organic acids produced by the decomposition of excretal matters, always present upon the roadways in use.

"(4) The porosity, or water-absorbing capacity, is of considerable importance. There is, perhaps, no more potent disintegrator in nature than frost, and it may be accepted as fact that of two rocks which are to be exposed to frost, the one most absorbent of water will be the least durable."

The following table shows the absorptive power of a few common stones:†

	Percentage of Water Absorbed.
Granites	0.06 to 0.155
Marbles	0.08 to 0.16
Limestones	0.20 to 5.00
Sandstones	0.41 to 5.48

* Highway Construction, p. 24.

† Byrne, Highway Construction, p. 26.

Something of the quality and suitability of different materials for use in broken stone pavements is shown in the following table:*

Materials.	Coefficients of Wear.	Coefficients of Crushing.
Basalt	12.5 to 24.2	12 1 to 16.
Porphyry	14.1 to 22.9	8 3 to 16.3
Gneiss	10.3 to 19.0	13.4 to 14.8
Granite	7.3 to 18.0	7.7 to 15.8
Syenite	11.6 to 12.7	12.4 to 13.0
Slag	14.5 to 15.3	7.2 to 11.1
Quartsite	13 8 to 30.0	12.3 to 21.6
Quartzose sandstone	14 3 to 26.2	9.9 to 16 6
Quartz	12.9 to 17.8	12.3 to 13.2
Limestone	6.6 to 15.7	6 5 to 13.5

These "coefficients," showing the relative quality of various road materials, were obtained by French engineers as the result of an extended series of tests, and were found to agree fairly well with the results arrived at by actual observation of the wear of materials in the roads. The coefficient 20 is equivalent to "excellent," 10 to "sufficiently good," and 5 to "bad."

Stones Not Suitable as Road Material.—Before proceeding to the consideration of the stones found in North Carolina adapted to use as road material, it may be well to consider briefly some of those that are not suited to this purpose. In general, it may be said that all *schistose* and *slaty* rocks, *i. e.*, all rocks which split or break easily into layers or flakes, should be discarded. No rock of whatever species which is already in the advanced stages of decay, so as to become crumbly and soft or porous, should be used, as the result in all such cases will be that, under the action of the wheels and hoofs, these materials become ground into fine powder, which becomes mud when wet, and dust when dry. There are other materials, like quartz ("white flint"), which are hard enough, but which are quite brittle, and hence easily crushed to powder, and which, consequently, should not be used when better material is available. Sandstones, as a rule, are unfit for use in macadamizing roads, as they are easily crushed and usually porous.

Stones Suitable as Road Material.—"The materials used for broken-stone pavements must of necessity vary very much according to the locality. Owing to the cost of haulage, local stone must generally be used, especially if the traffic be only moderate. If, however, the traffic is heavy, it will sometimes be found better and more economical to

* Byrne's Highway Construction, p. 172.

obtain a superior material, even at a higher cost, than the local stone; and in cases where the traffic is very great, the best material that can be obtained is the most economical."*

Stones ordinarily used in the construction of Macadam and Telford roads are the following: trap, syenite, granite, gneiss, limestone, quartzite, gravel and sand. The first three of these names are used here in a very general sense, and include a number of species of rock which, in technical language, would be known by other names. In general, it may be said that they rank in importance about in the order named, but several of them, especially the granite, gneiss and limestone, vary so much in quality that this general statement is subject to modification accordingly.

The term *trap*, as here used, includes not only the black rather fine-grain igneous rock known as diabase, which occurs in long dykes in the sandstone basins of Deep and Dan rivers, but also the somewhat similar material which is to be found in the older crystalline rock of many other regions. This rock does not split well into paving blocks, but when properly broken it is the most uniformly good material obtainable for macadamizing public highways.

Syenite, sometimes called *hornblende granite*, varies somewhat in quality and composition. It is a widely distributed rock in the midland and western counties of North Carolina, and is an excellent road material. The varieties which are finer in grain, and those having the larger proportion of the black mineral known as hornblende and are consequently of darker color, are best adapted for this purpose.

Granites vary considerably, both in quality and appearance, and in their value as road material. Those which are very coarse in grain, containing large and numerous crystals of feldspar, are, as a rule, more easily crushed and decay more rapidly, and should not be used in road construction when better materials are available. Those which contain a large proportion of mica split and crush more easily into thin flakes and grains, and, for this reason, are also less valuable. Those varieties which are of fine grain and contain a small admixture of hornblende are best for road purposes.

Gneiss, which has the same general composition as granite, also varies very greatly in its quality and adaptability to road building. It usually has the appearance of being somewhat laminated or bedded, and when the layers are thin and the rock shows a tendency to split along these layers it should be discarded for road purposes. In addition to this, the statements made above with reference to the granites will apply also to gneiss.

* Byrne, Highway Construction, p. 170.

Limestone suitable for road purposes is not an abundant rock in North Carolina, but it is found in a few of the eastern and a few of the western counties. It is a rock which varies very greatly in character, from the hard, fine-grained, compact magnesium limestone, which is a most excellent material for the Macadam and Telford roads, to the porous, coarse and partially compact shell-rock of recent geological formation, which is less valuable material. Practically, all limestones when used as road material possess one valuable qualification, that of "binding;" the surface material which becomes ground by the action of the wheels settles among the fragments below and consolidates the entire mass. For this reason, in many cases, it has been found to be good policy to mix a considerable quantity of limestone with some silicious and igneous rocks, which though hard and tough do not consolidate readily.

Gravel and Sand are not used in the construction of stone roads as formed by Macadam and Telford, except as an excellent foundation, for which purpose they possess a very great value; and as a binding material, in small quantities they are sometimes mixed with the crushed stone as the latter is spread over the road surface. When used in this latter connection, however, the gravel must be quite free from round pebbles. Gravel is, however, used extensively in the construction of what are termed gravel roads; where there is no attempt at macadamizing the roads, but where the gravel itself is spread uniformly over the surface of a foundation road-bed which has been properly shaped and drained.

DISTRIBUTION OF ROAD MATERIAL.

A line drawn from Gaston to Smithfield, Smithfield to Cary, and from Cary to Wadesboro, separates the State into two general and well marked divisions, the eastern of which may be called the Coastal Plain region, and the western may be termed Piedmont and Mountain regions.

In the Coastal Plain Region.—In the eastern counties, except along the western border of this Coastal Plain region at irregular intervals, we find none of the hard crystalline rocks suitable for making good road-bed. Over the larger part of the area we have sand, clays and loams, the sands becoming coarser and more gravelly along the western border and finer towards the eastern. At a number of points along some of the rivers and in some intervening areas is to be found a limestone rock which will serve a fairly good purpose in road building.

Gravel.—The gravels along this western border can be used successfully in making a fairly good road-bed, and should be used extensively where the hard crystalline rocks cannot be obtained. It may be found at many places in counties between the line mentioned above, extending from Gaston to Wadesboro, and a line drawn to the east of this from Franklin, Virginia, by way of Scotland Neck, Tarboro, La-Grange and Clinton, to Lumberton; and in a few places also east of this latter line. The gravel is more generally distributed along the borders of the river basins, where it occurs in extensive beds, a few inches to twenty feet in thickness, though along the western edge of the Coastal Plain region it is often found on the hill-tops and divides between the rivers.

In many places the gravel is suitable for use on the road-bed just as it comes from the pit, containing pebbles of the right size, from an inch down to a coarse sand, and a small percentage of ferruginous clay, just enough to make it pack well in the road-bed without preventing proper drainage. In many cases, however, the proportion of clay and loam and sand is too large and must be reduced by the use of fine screens; and in other cases many of the pebbles are so large that they must be separated by means of a one-inch mesh screen and broken before they can be used properly.

The railroads passing through this region long since discovered the value of this gravel as a road material, and have used it extensively as a ballast on their road-beds. The small percentage of ferruginous clay soon cements the gravel into a hard compact mass.

Limestone.—In the south-eastern portion of this region limestone rock and calcareous shells from the oyster and from fossil mollusks from the marl beds constitute the only hard materials to be found there for road construction. In some places the limestone is fairly hard, compact, as at Rocky Point, on the Northeast Cape Fear river, at Castle Hayne and elsewhere, and this rock will make an excellent road. In other places it is made up of a mass of shells firmly cemented together into a hard mass, as on the Trent river, near Newbern, and elsewhere. At many other points beds of shells are so slightly cemented together that the material may hardly be called a rock, as the term is ordinarily used, and in this condition it is of less value as a road material. A careful search will show limestone of one of these grades to occur in considerable quantities at many points in these eastern counties, between the Tar river and the South Carolina line. The harder, the more compact, and finer grain this rock, the more valuable it is as a road material; but the loose shells from marl beds, when free from clay, and the oyster shells from the coast,

when placed on a road surface and ground into fine fragments by travel, will solidify into a hard, compact road.

Clay and Sand.—The admixture of a small percentage of clay with the sand on the surface of the road-bed will solidify it, and will thus very greatly improve the character of the road; and in this connection, and only in this connection, clay may be considered a useful road material... In whatever region the clay appears in abundance, the road will be greatly improved by the proper admixture of sand from an adjoining region, and by proper drainage.

Granites and other crystalline rocks.—These are found outcropping at intervals along the western border of the Coastal Plain region, and wherever found accessible this material should be used in construction of roads. Near the northern border of the State they are found exposed in considerable quantity; along the Roanoke river, between Gaston and Weldon, in Northampton and Halifax counties; near Whitaker's Station, at Rocky Mount, just south of Wilson, and again a few miles north of Goldsboro on the Wilmington and Weldon railroad. Another isolated and interesting occurrence of granite is near the junction of Pitt, Wilson and Edgecombe counties, where it is exposed over a tract of several acres. West of the Wilmington and Weldon Railroad, in the counties of Halifax, Nash and Johnston, the streams have removed the surface sands and clay in narrow strips along their borders, and have exposed at intervals the crystalline rocks; and in many places these rocks will be found to make good road material. Further southwest, in Wake county, on the Cape Fear river, and Upper Little river in Harnett county, and again along the banks of the Pee Dee river and tributaries in Richmond and Anson counties, granitic and slaty rocks occur in considerable quantities, the former especially suitable for road material.

In considering the materials for good roads in the counties of this Coastal Plain region, it must also be borne in mind that several large rivers connect this region with ample sources of granite and other good road materials which occur at the head of navigation on these streams and can be cheaply transported on flats; and further, that a number of railroads pass from the midland counties where the supply is abundant directly into and across the Coastal Plain region.

Plank Roads.—As suggested above, in deep sandy regions where timber is abundant, the plank road may prove the most economical good road that can be built for temporary use, and some of them are fairly durable.

In the Midland and Piedmont Counties.—Throughout the midland and Piedmont counties of the State, west of the Coastal Plain

region, rocks suitable for road purposes are abundant, and widely distributed, so that no one can claim as an excuse for *bad* roads that the materials are not at hand for making *good* roads. It will serve our present purpose to discuss these in the order of their geographic distribution, with but little regard to their geologic relations.

Trap Rock in the Sandstone Areas.—As stated above, sandstones possess very little value as road material, especially when broken into small fragments, as is necessary in making Macadam and Telford roads, but, fortunately in this respect, sandstones of North Carolina are quite limited in their distribution. The larger of the two areas begins near Oxford, in Granville County, and extends southwestward, passing into South Carolina below Wadesboro. It has its maximum width of about sixteen miles between Chapel Hill and Cary, and its average width is less than ten miles. It occupies the southern portion of Granville County, the southern half of Durham, the western border of Wake, the southeastern border of Chatham, and portions of Moore, Montgomery, Anson and Richmond counties. The other sandstone area is much more limited in extent. It lies mainly in Stokes and Rockingham counties, along the Dan river, between Germantown and the Virginia line, a length of not more than thirty miles, and a maximum width of not more than five miles.

Fortunately for the roads leading through these sandstone areas, there is abundance of a hard, black, tough, fine-grained rock, known as diabase, or trap, occurring in dykes which have broken through the sandstones and now appear on the surface in lines of more or less rounded black masses of rock running nearly north and south. These dykes vary in width from very narrow to more than one hundred feet, and are separated from one another by distances varying from a few yards to two or three miles. A dozen or more of these dykes are crossed by the wagon road between Chapel Hill and Morrisville. Several dykes occur at and near Durham, and the rock has been used upon roads leading out from Durham, but unfortunately it has not been crushed into small fragments, as should have been done, and hence the result has not been altogether satisfactory.

There is, probably, in both these sandstone areas a sufficient amount of trap rock to properly macadamize every prominent road that crosses them, and, after this has been done, to furnish a top dressing for all public roads which are likely to be macadamized in the adjacent counties.

Trap Rock in Other Areas.—Fortunately, this excellent road material is, in its occurrence, not limited to the sandstone regions. Dykes quite similar to those which abound in the areas just described are

also found extending across the country in many of the midland and Piedmont counties, and also the region west of the Blue Ridge. Heretofore this black, "nigger-head" rock, as it is frequently called, has been regarded as a useless encumbrance of the ground; now, in connection with the move for better roads, it must be regarded as one of our most valuable rocks. The city of Winston has already made extensive use of it in macadamizing its streets.

The Eastern Granite Belts.—Granitic rocks are abundant over considerable areas in the midland and Piedmont counties, and especially in the former. One of these important areas may be called, as a matter of convenience, the Raleigh granite belt, which, in a general way, may be described as enclosed by lines drawn from Gaston to Smithfield, thence to a point midway between Raleigh and Cary, and thence a little east of north to the Virginia line. This belt occupies a considerable part of Wake, including the region about Raleigh, and of Franklin, practically the whole of Warren and Vance counties. The principal rocks of this belt are a light-colored gray, comparatively fine-grained, granite and gneiss; on the whole, a fairly good material for road construction. The rocks vary in composition and in appearance at different localities, but are fairly uniform in character over considerable areas. In some places the black or biotite mica is wanting, and the rock assumes a whitish felspathic character; at other points the mica becomes abundant, and the rock assumes a dark gray color. In places the mica is so abundant that the gneiss becomes somewhat schistose, or laminated, and in this condition crushes easily, hence should not be used on the roads. Dykes of trap rock are occasionally met with.

The somewhat isolated patches of granite lying east of this belt in Halifax, Nash, Edgecombe and Wilson counties have already been referred to.

West of the Raleigh belt there is another granite area of limited extent which occupies the extreme northeastern portion of Durham county and the larger part of Granville county. This may be called the Oxford granite belt. The rocks of this area resemble to some extent those of the Raleigh belt, but there is a larger proportion of syenitic and trap rocks, which make excellent road material.

The Central Granite Belt.—This belt extends obliquely across the State from near Roxboro, in Person county, to the South Carolina line along the southern border of Mecklenburg. Its width varies from ten to thirty miles, and it occupies a total area of about three thousand square miles in the following counties: western half of Person, including the region about Roxboro; the southeastern portion

of Caswell, the northwestern half of Alamance, the larger part of Guilford and Davidson, southeastern portions of Davie and Iredell, Lincoln and Gaston and the larger part of Rowan, Cabarrus and Mecklenburg. In this belt throughout its entire extent road material of most excellent quality is abundant. The prevailing characteristic rocks are syenite, dolerite (trap), greenstone, amphibolite, granite and porphyry; and, as will be seen from this list, the tough hornblende and angite rocks predominate. Dykes of trap rock, some of them of considerable extent, are to be found in almost every portion of the belt. So uniformly tough and durable are these materials, that one could hardly go amiss in making selections for road construction.

The Central Slate Belt.—This region lies just east of the central granite belt, and extends obliquely across the State from Virginia to South Carolina. Its eastern border lies against the Deep river sandstone basin described above (p. 23). It varies from twenty to forty miles in width and includes all or portions of the following counties: the eastern half of Person, the northwestern part of Durham, the southeastern part of Alamance, nearly all of Orange, Chatham, Randolph, Montgomery, Stanly and Union; the eastern part of Davidson and Rowan, and the northwestern part of Anson. A considerable portion of this area is rich in other mineral products, but the entire belt as compared with the central granite belt, is poor in road materials. The rocks are mostly siliceous and clay slates, with a considerable admixture of chloritic and hydromicaceous schists; all of which are at best inferior for road construction. Here and there, however, trap dykes are found in this belt; and in places the siliceous slates become somewhat massive, passing into hornstone and a quartzite, which, when crushed, will answer fairly well for macadamizing purposes. In other places the chloritic schists become somewhat massive and tough and can be used in the same way. In still other places, as about the State University, and along the eastern border of Orange County, the rock is a fine-grained, tough syenite, accompanied by trap dykes, and is eminently suited for road purposes; and again, as near Hillsboro, granite occurs in a limited area. Vein quartz ("white flint") is abundant in many parts of the belt; and, though not usually recommended as road material, is worthy of consideration. While then, on the whole the rocks of this belt are not suitable for use as road material, yet a careful search will show the existence of a sufficient quantity of material of fair quality to macadamize all the public roads. And should this supply ever prove insufficient, excellent materials are to be found in abundance in the granite belt along the western border of this region, and in the trap dykes of the sandstone on the eastern border.

The Gneisses and Other Rocks of the Piedmont Counties.—West of the central granite belt as described above, and extending back to the foot-hills of the Blue Ridge, is the region occupied by the Piedmont counties—Rockingham, Stokes, Forsyth, Yadkin, Surry, Wilkes, Davie, Iredell, Alexander, Caldwell, Burke, McDowell, Rutherford, Polk, Cleveland, Catawba, Lincoln and Gaston. The rocks of this region resemble in many respects those of the Raleigh granite belt. They consist of a succession of gneisses, schists and slates, more hornblendic toward the east and more micaceous toward the west, with here and there masses and dykes of syenite, trap and other eruptive rocks. In places, as at Mount Airy, the true granite occurs in considerable abundance. The granites and gneisses, except where the latter tend to split into thin layers and crush, are fairly good materials for road construction, improving as they become finer in grain and as the percentage of hornblende increases; but the best material for road construction is to be found in the trap dykes and syenite ledges which at intervals traverse this region, more especially its eastern half.

The Gneisses and Other Rocks of the Mountain Counties.—The rocks of this region are not greatly unlike those of the Piedmont counties just described. Over much the larger part of the area rock fairly well adapted to road construction is abundant, indeed so abundant that the laborers on the public roads in that region during the past half century have expended the larger part of their time and energy in endeavoring to get this rock out of the way. Had they expended this time and energy in crushing the rock and spreading it over a well-formed foundation, this region would possess at the present time a number of excellent macadamized highways.

In the more northern counties—Alleghany, Ashe and Watauga—the predominating rocks are hornblende gneiss and slate, but massive syenites are abundant, especially between Rich mountain in Watauga and Negro mountain in Ashe county, and elsewhere. Further southwest, through Mitchell, Yancey, Madison and Buncombe counties, hornblende schists still continue, but they are more massive, and the gneisses predominate. These are, on the whole, compact and sufficiently tough for use in the construction of good Macadam roads. And the statement just made concerning these counties is also applicable to Henderson, Transylvania and Haywood counties, and in a measure to Jackson, Swain and Macon counties and the eastern half of Clay county, in all of which the supply of good road material is ample; but in these last three counties mica schist partially replaces the hornblende slate. In the western part of Swain, in Graham, Cherokee

and the western part of Clay county good road material is not so abundant as in the other counties named, but nevertheless is to be found in considerable quantities. The rocks over a considerable portion of this last-named area are micaceous and hydro-micaceous in character, and are practically worthless for the purposes of road building, but the quartzite ledges and beds of limestone in these counties will furnish ample and suitable material.

In conclusion, it may be said that in the middle and western counties of North Carolina material suitable for macadamizing the public highways is abundant and generally accessible. It will be the exception, rather than the rule, that this material will have to be transported for any considerable distance. In the eastern counties materials suitable for this purpose are inferior in quality and only moderately abundant in quantity, but the extensive and intelligent use of even these materials would very greatly improve the public roads and thereby increase the prosperity of the people. And in many places where the Macadam road is at present out of the question on account of the lack of stone, other materials, gravel, clay, loam and plank will be found in sufficient abundance to make the construction of better roads practicable, at reasonable cost.

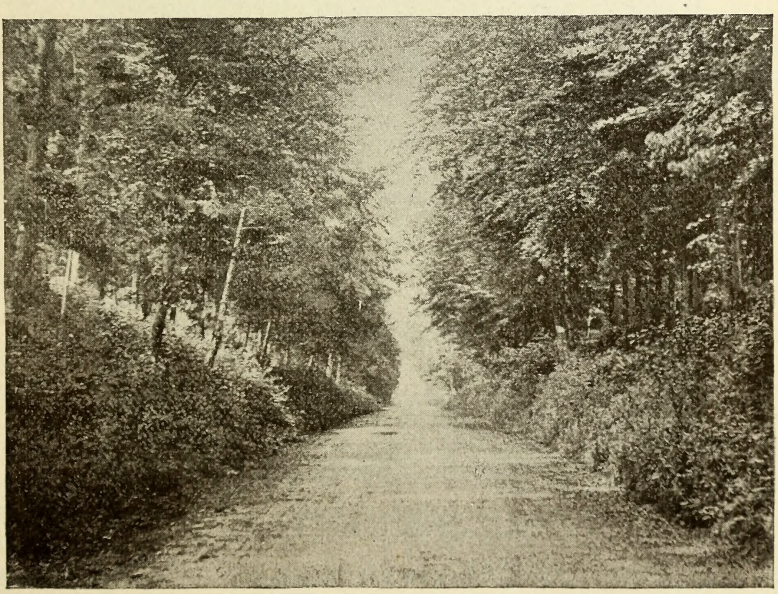
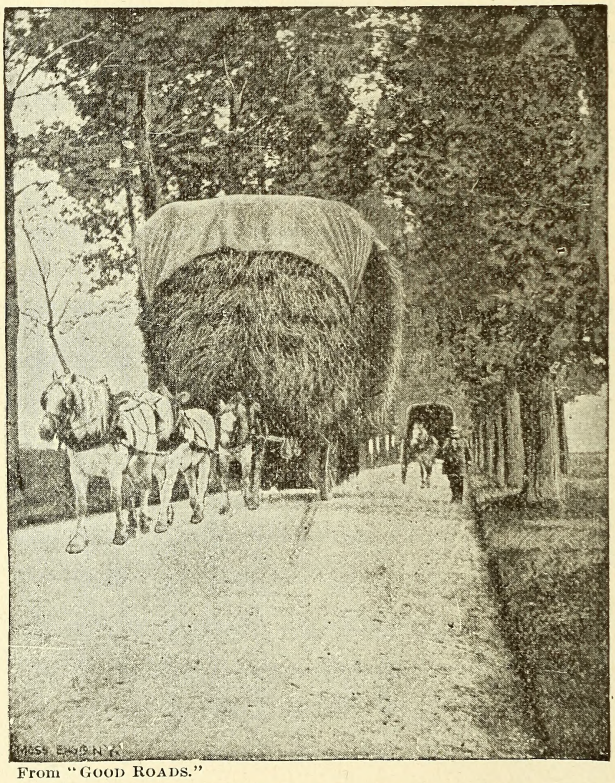


Fig. 4.—AN ENGLISH COUNTRY ROAD OF TO-DAY, MACADAMIZED.
(FROM "GOOD ROADS.")

CHAPTER TWO.

THE PUBLIC ROAD PROBLEM IN NORTH CAROLINA.

It has been well said that * "Every member of society is interested in the public road. At birth, at death, and at all intermediate points during life it is used, to a greater or less degree, by or for every individual member of society. It carries the doctor to the bedside of the sick, the minister to administer consolation to the dying, friends to the



From "Good Roads."

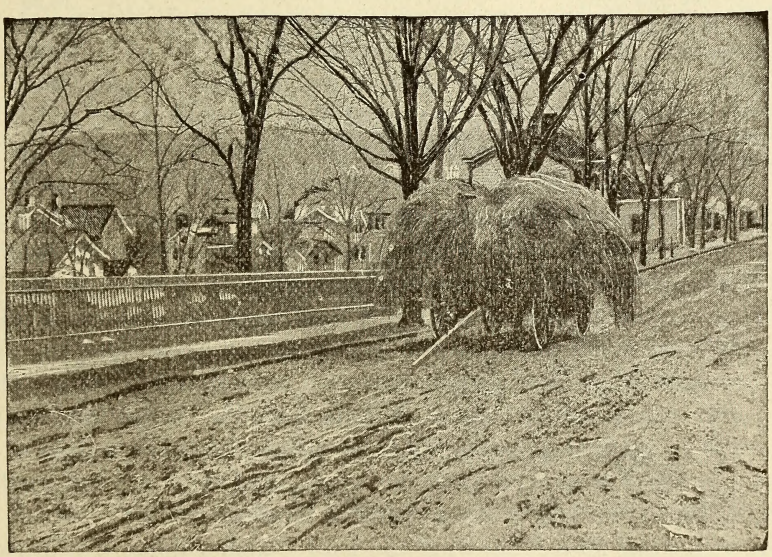
Fig. 5.—A LOAD OF HAY SUCH AS IS ORDINARILY HAULED ON A MACADAMIZED FRENCH ROAD.

house of mourning, and the dead to their graves. It brings purchaser and consumer together. It is the avenue alike of pleasure and of traffic. The farmer seeking his market, the commercial traveller looking for customers, the millionaire in search of enjoyment with his coach-

* Ex-Governor Beaver, of Pennsylvania, in the *Forum*, Vol. XIII, 1892, p. 773.

and-four, the wheelman in the pursuit of health, the few seeking pleasure and profit on wheels, and the many in like pursuits on foot — all are interested in the public roads. And yet, direct and immediate as these interests are, we are content to follow the methods of half a century or more ago, to submit to inconvenience, to discomfort, and to the immense waste of money and patience."

The greatest obstacle in the way of the move for better roads among the American people, who are always loth to increase the "burdens of taxation," is the item of cost; and this will continue to be the case until the people come to realize the fact that *bad roads cost more than good roads*. But the campaign of education has already begun, and in the hope of aiding in this work I have introduced the few following facts concerning certain items of cost.



From "Good Roads."

Fig. 6.—A LOAD OF HAY WHICH TWO LARGE HORSES WERE UNABLE TO PULL ON A MUDDY AMERICAN DIRT ROAD.

*Cost of Wagon Transportation.** — "It is apparent that but few people comprehend the cost of transportation by horses and wagons, or realize the amount of money annually wasted by the ill condition of the roadways."

The following table "shows from actual observation the cost of moving a load of one ton a distance of one mile on level roadways with different pavements in the usual condition in which they are maintained. The excessive amount of these charges is seen, when it is

* Byrne, p. 2.

remembered that the same goods using the roadways are now carried by the railroads at an average cost of $\frac{6}{10}$ of a cent" per ton per mile:

COST OF TRANSPORTATION BY HORSES AND WAGONS, HAULING ONE TON A DISTANCE OF ONE MILE ON DIFFERENT ROAD-COVERINGS.

On iron rails	1.28 cents.
" asphalt	2.70 "
" stone, paving, dry, and in good order	5.33 "
" " " ordinary condition	12.00 "
" " " covered with mud	21.30 "
" broken stone road, dry, and in good order	8.00 "
" " " " moist and in good order	10.30 "
" " " " ordinary condition	11.90 "
" " " " covered with mud	14.30 "
" " " " with ruts and mud	26.00 "
" earth, dry and hard	18.00 "
" " with ruts and mud	39.00 "
" gravel, loose	51.60 "
" " compacted	12.80 "
" plank, good condition	8.80 "
" sand, wet	32.60 "
" sand, dry	64.00 "

It will be seen from the above table that in hauling a load of one ton over one mile of level road, it costs more than twice as much to haul this load over the best dry dirt road, about five times as much to haul it over a moderately muddy dirt road, and eight times as much on a dry, deep-sandy road, as it does to haul the same load the same distance on the best dry, broken-stone or macadamized road. These facts, and others given below in this and the following chapter, will serve to show that better roads are needed in every section of the State — in the east as well as in the west — and that our bad roads in every section are a heavy and expensive burden.

The following table,* showing the load which a horse can draw on different grades, will serve to illustrate the fact that the many steep hills on the roads through the middle and western counties of the State are a serious drawback to travel, and a heavy item of expense. The fact that such is the case will be all the more apparent when we remember that the weight of a load which a team can haul is limited, not to what it can pull over the larger part of the road, but to what it can pull up a certain hill over which the road passes, or across a certain muddy flat through which the road may lead.

* Byrne, p. 270.

LOAD A HORSE CAN DRAW ON DIFFERENT GRADES ON THE VERY BEST MACADAM ROAD.

Rate of Grade. Feet per 100 Feet.	Equivalent Length of Level Road—Miles.	Maximum Load in Pounds which a horse can haul.
Level surface, very best Macadam road	1.000	6,270
1 foot rise in 100 feet, "	1.500	4,145
2 feet rise in 100 feet, "	2.000	3,114
3 feet rise in 100 feet, "	2.484	2,486
5 feet rise in 100 feet, "	3.444	1,800
7 feet rise in 100 feet, "	4.844	1,367
10 feet rise in 100 feet, "	5.977	1,030

It will be seen from this table that an average horse weighing 1,200 pounds can pull six times as much on a good level road as he can pull up a hill which rises 10 feet in a distance of 100 feet (and such hills are numerous in the middle and western counties of North Carolina); and it also shows that on such a good road it requires as much force to haul a given load up a mile of such steep grades as it does to haul the same load over 6 miles (5.977) on a level surface. In the following chapter of this report it is shown still more clearly that a single steep hill may double, or even quadruple, the cost of hauling over a given section of road.

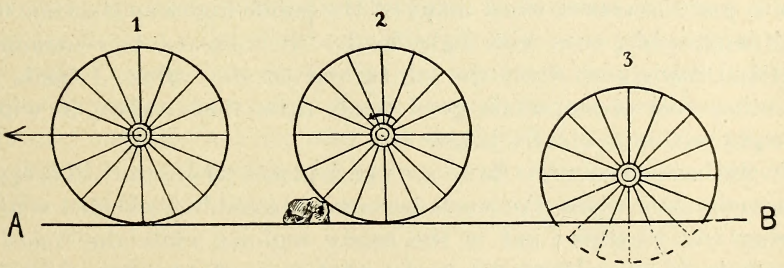


Fig. 7.—ILLUSTRATING THE DISADVANTAGES OF BAD ROADS. NO. 1 REPRESENTS A WHEEL ON THE SMOOTH HARD SURFACE OF A GOOD ROAD WHICH OFFERS VERY LITTLE RESISTANCE TO THE FORWARD MOVEMENT OF THE LOADED VEHICLE. NO. 2 IS A WHEEL RESTING ON THE HARD SURFACE OF A ROAD COVERED WITH LOOSE OR PERMANENT FRAGMENTS OF STONE. NO. 3 IS A WHEEL PARTLY SUNK INTO THE SURFACE OF A MUDDY ROAD.

The accompanying figure will serve to illustrate some of the obstacles in the way of hauling heavy loads over the ordinary dirt highways. Wheel No. 1 of the figure is supposed to rest on the smooth hard surface of a good Macadam road. It does not sink into the surface and has no obstacles in front of it; consequently it is easily pulled forward whatever weight it may bear. Wheel No. 2 also rests upon a smooth hard surface, but there is a stone in front of it; and before it can

move forward the horse must not only pull the load but must also actually lift one-fourth of the entire weight of the load and vehicle to the top of the stone—supposing that the vehicle has four wheels; if it has two wheels he must lift half of the total weight. Wheel No. 3 is supposed to be on (or in) a winter-time dirt road and has sunk in mud half-way to the hub. Before going forward the horse must either lift this wheel out of the mud, in which case he must not only lift the entire weight of the load—supposing all of the wheels to be in the mud—but he must also lift an indefinite weight of mud and overcome a considerable amount of friction between the sides of the rim of the wheel and the mud into which the wheel has sunk before he can raise the vehicle on to a hard road surface again.

Other Items in the Cost of Bad Roads.—In estimating further the cost of bad roads, we should take into consideration the loss of time by horses and men, the cost of maintaining the same during such lost time, the injuries and the wear and tear to the horses, vehicles and harness caused by the bad roads. We should also take into consideration the small loads that must be hauled over these roads, frequently not one-fourth of a full load, and we must bear in mind the fact that during the winter months, when ordinary farm work cannot be carried on, is the time when wagons and teams should be mostly used on the roads in going back and forth to markets, etc., but this is just the season when many of the public highways become well-nigh impassable, even with light loads. It must also be remembered that bad roads keep down the selling and taxable value of lands and all other real estate, while good roads raise these values, as will be brought out more clearly below.

In the eastern counties there are many places where the soil is clayey or marshy, and where the roads become impassable for loaded vehicles during wet weather; but in the sandy regions, while the roads are always bad and make wagon transportation costly, hauling over them is less costly when the sand is wet than when it is dry. In the middle and western counties, however, it is during the wet weather that the roads become so bad as to be practically impassable for loaded vehicles for from four to twelve weeks of each year.

In order to determine approximately how much our bad roads cost the people of the State, let us see first how much four weeks of impassable roads cost in the middle and western counties, and then how much the bad roads of the whole State cost us during other portions of the year by increasing the number of horses and mules which must be purchased and fed, the number of teamsters who must be paid, and

the number of wagons and harness which must be purchased and kept in repair, because in travelling and hauling we use these bad roads instead of good roads. We have now in the State, in round numbers, 260,000 horses and mules.* We may deduct from this number 50,000 which, in the cities and towns, can be used during the entire year, and there remain 210,000 horses and mules which, for our present purpose, may be designated country horses and mules.

Adopting the line of geographical division described on page 20, we may credit 134,000 of these to the fifty-six middle and western counties, and 76,000 to the forty eastern counties. These 134,000 country horses and mules credited to the middle and western counties cannot be used during four weeks of the year on account of bad roads. The cost of feeding them per day, at twenty cents each is $26,800, which for the four weeks amounts to $750,400. Now let us add to this the item of the loss of time for these animals. Putting this at twenty-five cents per day (twenty-four days), we see another source of loss amounting to $804,000. These two items give us a total of $1,554,400 per annum which may be charged against the impassable public roads. Let us add to this the cost of the following items which will amount in the aggregate to certainly not less than $50,000: (1) Value of the service of ox-teams and the cost of feeding them during the four weeks; (2) and the loss farmers sustain by not being able to carry farm produce, tobacco, cotton, etc., to markets at times when prices are highest; and the result presents at a reasonable estimate, a total loss of more than $1,600,000 per annum to be charged against excessively bad public roads in North Carolina during these four weeks.

We may suppose that one man was employed in the management of each pair of these 134,000 horses and mules of the midland and western counties. Of these 67,000 teamsters we may fairly suppose that one-half of their time during the four weeks lost by the horses and mules was profitably employed in other ways about the farms; but we may also fairly consider the other half of their time as lost on account of bad roads. Valuing the services of these men at fifty cents per day and charging one-half of this as lost, owing to bad roads, we have 67,000 men at twenty-five cents, equal to $16,750 per day; and for four weeks $402,000. While this is believed to be a real loss due to bad roads it will not be included in the final estimates of the total loss, because

*The number of horses and mules in North Carolina during 1891, as given in the Auditor's Report for 1892, p. 107, is 253,614. The increase from 1890 to 1891 was 13,046, hence the number for 1893 may be safely estimated at 260,000; and supposing that these additional horses and mules to be distributed among the several counties in the same proportions as existed in 1891, we may estimate, after deducting the 50,000 town horses and mules, the remaining number of country horses and mules now in the fifty-six middle and western counties as 134,000, and the number in the eastern counties as 76,000.

there is a reasonable doubt as to the amount of actual loss from this source.

But then there is another large item that must be taken into consideration. I have estimated that this $1,600,000 per annum is lost during four weeks when the roads are so bad as to practically prevent all hauling. But it must be remembered that even when the dirt road is in good average condition, the loads hauled are not more than one-third those hauled on good Macadam highways. The average load for one horse on a macadamized country road in France is said to be two or three tons, and on the paved streets of a French city one horse often pulls three to five tons; whereas, taken month in and month out, the load for one horse on the average American dirt road is less than half a ton. It can therefore be safely claimed that if we had good macadamized roads, the hauling we now do in two months could be done in less than half the time; or if extended over two months, it could be done by less than half the teams and teamsters and wagons now employed.

Of our 210,000 country horses and mules, including the eastern as well as the western counties, of course many of them do but little hauling on the public roads at any time; but there are also quite a number that spend the larger part of the year on the road; and there are others which go on the road at irregular intervals as there is extra hauling to be done. It is probably safe to estimate that all the hauling over the public roads during the year would require the constant employment of the entire 210,000 horses and mules and 105,000 teamsters and wagons during at least two months, with the roads in their present average condition, and would require their employment during one month on good Macadam roads. Here, then, is an important item of loss on account of bad roads, *i. e.*, the services and cost of maintenance of these horses and mules, teamsters, wagons and harness during one month. In this case it is manifestly proper to include in the estimate the wages of teamsters, who spend all of their time with the teams and are paid full wages, while the teams are pulling half loads, and hence losing half of the time. Valuing the services of these 210,000 horses and mules at twenty-five cents per day each (twenty-four days), we have an item of $1,260,000; estimating their feed per day at twenty cents each,* twenty-eight days, we have another item of $1,176,000; and these combined show a loss of $2,436,000 for the

* It is generally estimated that to feed a horse or mule while regularly at work costs twenty-five cents per day; and while this is probably correct for horses where the feed has to be bought at the average market prices, where the corn, fodder and oats are grown on the farm and hence are to be valued at prices for which they can be sold on the farm, I have estimated the cost of feeding a horse while at work at twenty cents per day.

month. The pay of 105,000 teamsters, estimated at fifty cents per day each, gives an item of $52,500 per day and $1,260,000 for the four weeks. The wear and tear on the 105,000 wagons and harness, if placed at ten cents per day while in constant use, gives an item of $10,500 per day and $252,000 for the four weeks. Add these several items and we have a sum of $3,948,000 annually lost to the people of the State by having poorly laid out and constructed dirt roads instead of good Macadam roads, not including the loss during the four weeks when the roads are impassable. That this is an actual loss will be seen more clearly when we understand that the amount of hauling which could be done at a profit will greatly increase as we make good roads, and thus reduce the cost of wagon transportation.

But there is yet another item which must be included in this general estimate before the grand total is reached. In the beginning of this discussion we left out of consideration fifty thousand of the horses and mules in the State as being approximately the number about the cities and towns which can be used throughout the entire year. The suburban roads and many of the streets of these towns, however, are kept in such poor condition that we may safely estimate that if these streets and suburban roads were properly macadamized, these 50,000 horses and mules and their drivers could do twice the work they now do, or one-half of them could easily do all the hauling now done, and the other half might thus be easily dispensed with, and the cost of horse feed, wagons, harness and teamsters saved. Let us see what this saving would amount to if the latter plan were adopted. It costs to feed these 25,000 horses and mules, at twenty-five cents* per day each for the year, in round numbers, the sum of $2,281,000; and for these horses 12,500 teamsters are required, which, at fifty cents per day, cost for 300 days $1,875,000; and 12,500 wagons and harness, at ten cents per day (for 300 days), $375,000; making a total of about $4,531,000 per annum from these sources, which may fairly be charged against our inferior roads and streets.

If we now estimate that there are in the State 220,000 citizens† who are liable to work on the public roads four days of each year, and value their services at fifty cents per day, we have the sum of $440,000, which, whether expended in money or muscle, may be considered an annual tax for public roads. But, in spite of this large expenditure, year after

*See note on page 34.

†The poll-list for 1891, which is supposed to include all male citizens between the ages of twenty-one and fifty years, shows 221,530 individuals. The general road law makes all male citizens between the ages of eighteen and forty-five years liable for work on public roads, and the total number of such persons is hardly smaller than the poll-list.

year and decade after decade, we have not in the State to-day a public highway worthy of the name.

Let us now bring together the results of these several estimates:

Loss on account of the cost of feeding, and loss of time by the 134,000 country horses and mules in the middle and western counties, during four weeks of impassable roads, etc., (p. 33)	$ 1,600,000
Loss, on account of bad roads, of the time and expenses of maintenance of 210,000 country horses and mules, 105,000 wagons and harness, and wages of 105,000 teamsters, during one month (p. 34)	3,948,000
Loss, on account of bad roads, of the services and expense of feeding 25,000 town horses, and services of 12,500 teamsters, and wear and tear on 12,500 wagons and harness, all of which could be saved by having good roads and streets (p. 35)	4,531,000
Wasted in working public roads in taxes and labor (p. 35)	440,000
Total	$10,519,000

The aggregate of these several items gives a grand total of over ten million dollars, which sum the people of the State lose annually on account of bad roads, and which sum might be saved annually to the State by a system of good macadamized roads.

I am aware that many will question these astonishing figures, but they are careful estimates—not random guesses. And while admitting that there are many sources of possible error, I am satisfied that whoever examines the estimates candidly will be profoundly impressed with the fact that on account of these bad roads the people of North Carolina are suffering yearly enormous losses without any compensating return, and of the magnitude of which they seem to be hardly conscious; and it must be remembered that every year, as trade increases, and with it the number of horses and wagons and teamsters, we must use these bad roads more and more, and the losses they entail thus increase annually. These losses are, in an important sense, equivalent to an annual tax on the people of the State of ten million dollars, paid largely by the farmers who own the stock and wagons, but paid also in part by every man, woman and child in the State.

England and France each expend eighteen million or more dollars annually in the maintenance and extension of their splendid systems of macadamized highways, and regard the investment a good one; but the people of North Carolina, too poor, as they claim, to build good roads, nevertheless bear annually this enormous burden for the privilege, as it were, of doing without them.

And what do we get in return for this large drain upon the wealth of our people? A system of dirt roads, sandy in one region and clayey in another, which, as compared with macadamized highways, retard or prevent travel; diminish or prevent investment of capital;

keep intelligent settlers away; retard and greatly increase the expense of all transportation and exchange of commodities between farms and markets; decrease the profits of farming; interfere in the country with proper attendance at the schools and at churches; prevent proper social intercourse among people in the country, and between those living in the country and those in towns; make young people and old people dissatisfied with living in the country and anxious to move to towns and cities, where they can walk, ride or drive with some degree of comfort; keep down the value of all lands and other real estate; prevent the inauguration of many mining, manufacturing and other enterprises, by making wagon transportation too expensive. In a word: in exchange for this heavy annual burden we have an expensive system of bad roads which greatly retards the material, social and intellectual development of our people, and is a standing discredit to our civilization.

And how long will this continue to be the case? What are we waiting for? How long will it be before the intelligent men of the State join earnestly in this move for better roads? How long will it be before our people, instead of asking for a "reduction of the burdens of taxation," already exceptionally light, will come to understand that it will pay to expend a considerably larger portion of our labor and money in the development of such internal improvements as the construction of better public roads? How long will it be before we all come to realize the imperative need of better roads sufficiently to determine to have them, whatever sacrifice may be necessary in order to pay for them? If we wait until the country increases in wealth we may expect to "make haste slowly," for certain it is that bad roads tend to perpetuate our poverty, and as equally certain it is that good roads tend to increase the wealth and prosperity of the people.

Farming lands in many parts of the United States during the past few years have decreased in value. Ex-Governor Campbell stated recently that this decrease in value of farming lands amounts in Ohio to $220,000,000 in ten years. The abandoned farms in many States are numerous. The mortgage indebtedness of American farms during the past few years has increased at the rate of $2,500,000 per annum.

After mentioning these facts in a recent article in the *Forum*, Mr. I. B. Potter continues:*

"It is of course no easy task to charge these sluggish conditions and shifting fortunes of agriculture to any certain cause; but, in searching for a solution, certain facts appear with such conspicuous prominence as to make them worthy of mention; viz., that with the same physical conditions, the same market, and unchanged prices of

*Vol. XII, 1891-'92, p. 380.

farm produce, the American farm has in late years substantially declined in the market value; that the value of farm-produce in a given locality is, in general, determined by the price offered in the local market; that the farmer pays the same for all that he buys, and gets no more for what he sells, whether his farm be near or distant from the market-town; that under these conditions the most immediate means of relief is to diminish the total cost of placing this produce in the market-town; that an amazing share of this cost is made up by the difficulties of wagon-road transportation, necessitating scant loads, long delays, mud blockades, breakdowns, and extra trips; that these or similar hampering conditions are tolerated by no other industrial class within the nation; and finally, that the quickening means for work, travel, and transportation adopted within and between the mercantile industries of the different towns have added to the attractiveness and profits of these pursuits, and by force of contrast have detracted from the commercial value of the neighboring farms."

The depression among agricultural interests during recent years is indeed a complicated question, and concerning its causes and remedies there are grave differences of opinion; but there is among the thoughtful statesmen of to-day a striking unanimity of belief that bad roads are a large factor in causing this depression, and that good roads will greatly aid in relieving it.

The cost of good roads.—I have endeavored to show above approximately how much our present system of bad roads costs the people of the State; and in stating this at $10,000,000 per annum, I believe that this estimate is below rather than above the actual loss. It must be apparent to every one that at any reasonable cost per mile, the annual expenditure of a small portion of this sum in road improvement would give us a system of public highways, which in a short time would much more than pay for themselves.

The cost per mile of the improved public roads will be discussed more fully in the next chapter, in connection with the treatment of the methods of construction. Of course the cost will depend largely upon the kind of road to be made, but it may as well be clearly understood that the construction of any public highway which is to be worthy of the name, and which is to be of any real and lasting benefit to the communities through which it passes is an expensive undertaking. The re-surveying, grading, proper drainage and other work in improving a good dirt road, may cost under different conditions from $100 to $500 per mile. Macadamizing these dirt roads, already graded and drained, with different widths of road, different thicknesses of broken stone and other varying conditions, may cost from $1,000 to $10,000 per mile.

Does it pay to build good roads?—In view of this large outlay necessary for the construction of good roads, let us face the issue squarely and ask ourselves the question: Does the investment pay? Are the disadvantages of bad roads on the one hand and the advantages of

good roads on the other, sufficient to warrant the large expenditures necessary for the construction of better public highways? In view of the fact that most of us have had but little opportunity to become acquainted with good roads and their advantages, it is clear that we must, in large measure, look to the experience of other States and other countries for a full answer to this question. In doing so, however, let us understand clearly our present position. We stand between the two horns of a dilemma, and we must accept one or the other. We may let our public roads remain as they now are, and continue to bear for this privilege a burden amounting to several millions a year without any compensating return; or by a smaller additional annual expenditure, in a few years we may in large measure rid ourselves of this burden, and meantime build a system of public highways which will bring unnumbered blessings to the people of the State.

England and Wales are said to expend annually $20,000,000 in the maintenance of their public highways; and Scotland and Ireland expend large additional sums. The people of each of these countries regard the investment as a good one, and are even extending their costly roads.

France expends on her highways not less than eighteen million dollars per annum; and referring to the economic worth of these roads to the French people, Mr. Francis B. Loomis, commercial agent at St. Etienne, France, reports to the United States Department of State as follows:*

"The road system of France has been of far greater value to the country as a means of raising the value of lands, and of putting the small peasant proprietors in easy communication with their markets, than have the railways. It is the opinion of well-informed Frenchmen who have made a practical study of economic problems that the superb roads of France have been one of the most steady and potent contributions to the material development and marvelous financial elasticity of the country. The far-reaching and splendidly maintained road system has distinctly favored the success of the small landed proprietors, and in their prosperity, and the ensuing distribution of wealth lies the key to the secret of the wonderful financial vitality and solid prosperity of the French nation."

And if it be claimed that we should not look to these wealthy countries for our examples, we may turn to Australia and Canada, both of which have a system of public roads far superior to our own, even in regions more thinly settled and less wealthy.

In our own country, limited sections of macadamized roads have been built in portions of Massachusetts, Connecticut, Rhode Island, New Jersey, Pennsylvania, Indiana, Kentucky, Tennessee, Virginia

*Streets and Highways of Foreign Countries, Consular Reports, United States Department of State, Government Printing Office, 1891, p. 51.

and other States. And in every case where a sufficient amount of money has been raised for the construction of really good roads, whether by tax levy or sale of bonds, the people generally have regarded the investment as a good one, and have been more than satisfied with the result.

For example, Union county, New Jersey, in 1889 issued $300,000 worth of four per cent. bonds, and raised by taxation $25,000 each for 1889 and 1890, making a total of $350,000, which was expended in the construction of good Macadam roads, beginning in 1889 and completing the work early in 1891.* Before the improvement work began "the roads were dusty, sandy, stony, or so muddy that they were impassable, and so dangerous that the road authorities were indicted year after year by grand juries. All the land was *simply out of the market;* nobody wanted it." One piece of property of twenty acres, with house and other buildings, within a mile of Elizabeth, was a drug in the market for years at $6,500, and was finally sold at $6,000, before the Macadam roads were built. Within a year after the roads were completed the owner refused $30,000 for it, without having invested a dollar in improvements.

"The accretion of new wealth, induced to come to the county by the good roads, aggregates several times the cost of the roads. Farmers say that under no consideration would they return to the old system. Some of them say that the new roads have raised the value of property as a whole along them, from fifty to one hundred per cent. Others declare that the saving in harness, wagons, horses, etc., is equal to the amount paid for the roads." One of the new macadamized roads runs parallel with the Central Railroad of New Jersey, and along this line four new stations have been erected and promising towns started. Notwithstanding the payment of the interest on the bonds and special tax for two years, the rate of taxation was not appreciably increased; but on the contrary, was one cent less on the one hundred dollars in 1892 than it was before the construction of the new roads was begun. This is to be explained by the fact that from the beginning of 1889 to end of 1892 the increase in the value of property of the county amounted to nearly $4,000,000. In every way these roads "have been a splendid success. They have far more than fulfilled every expectation and every promise made for them."

Along the line of the Shenandoah Turnpike, in the Valley of Virginia, the president of the company says that the construction of this

*The results of this liberal investment in road construction will be stated in "Good Roads" for March (1893), in a paper by Mr. Charles C. McBride, of Elizabeth, Union county, New Jersey, chairman of the New Jersey committee on good roads of the League of American Wheelmen. Through his kindness I am permitted to publish in advance the accompanying facts and extracts contained in a private letter to the writer.—J. A. H.

macadamized turnpike years ago raised the value of the property along its line more than twenty-five per cent.; and a like result is said to have attended the construction of similar turnpikes in other parts of this region.

In Wake, one of the larger and wealthier counties of our own State, Macadam roads are being constructed, and are giving general satisfaction. Here 100 miles of Macadam roads would be equivalent to six such roads averaging each 16.6 miles in length leading in different directions from Raleigh to near the county boundaries. That it would pay the people of Wake county to build these and other roads, even should they cost a large sum, and that this would raise the selling value of land and other real estate in the county 10 to 30 per cent. no one who has studied the question can doubt.

In Mecklenburg county, which has done more toward improving its public roads than any other of the counties of our own State, there has been an increase in the value of property along the macadamized roads, and the people are so well satisfied that the investment is a good one that they continue cheerfully to tax themselves to extend the work. And so it is in all countries, and so it will be in every county in our own State; wherever a sufficient extent of good roads has been constructed to enable people living along the line to realize their advantages they become satisfied that good roads are indispensable, and that it pays to build them, whatever sacrifice may be necessary in order to do so.

Mileage of Public Roads in North Carolina.—It is of course impossible to give accurately the total mileage of public roads in the State owing to the fact that the majority of these roads have never been carefully surveyed and measured. But an approximate estimate based upon the best maps obtainable and extended observations in many counties shows a total for the State of (1) about 10,000 miles of prominent public roads radiating from the county seats to the borders of the counties, and (2) about 10,000 miles of cross-roads leading through various portions of the several counties. (3) In addition to these there is a considerable mileage of roads — probably 20,000 miles in all, some of them public and some private — of comparatively little importance, which are not included in this estimate. This would give an average of about 200 miles of prominent public roads for each county in the State, *i. e.*, 100 miles of roads leading from the county seat out through the country, and 100 miles of cross-roads; and an average of 200 miles of lesser public and private roads for each county. In many of the larger counties the mileage is greater, and in many of the smaller counties it is less than this average.

A few Practical Suggestions.—Admitted that our present inferior roads tend to perpetuate our poverty and retard the development of the State; admitted that it will pay to build better roads, whatever reasonable sacrifice may be necessary in order to do so—it may not be out of place in concluding this chapter to offer a few suggestions relative to certain phases of the road problem in North Carolina.

In the introduction to this Report (pp. 14–16), I have stated some general conclusions which need not be repeated here. In Chapter I. I have endeavored to show that in the midland and western counties the materials out of which to construct good roads are abundant; and that even in the eastern counties, while stone is less abundant, or entirely wanting, the intelligent use of such materials as can be found in these counties will result in greatly improving the public roads.

The raising of funds sufficient for the work is the most urgent and difficult phase of the public road problem which now awaits solution. But there is everywhere in the State a growing recognition of the principle that in building and maintaining public roads, property should coöperate with labor; and hence that it is right and wise to raise funds for this purpose by taxation. In wealthier counties like Mecklenburg, Wake, Guilford, Forsyth, Cabarrus, Buncombe, Alamance and others, which are already entering upon the work of road improvement, the demand for better roads is becoming so urgent that the funds will be raised by taxation or bonds with increasing ease as the work progresses; but in the smaller and more thinly settled counties the raising of funds ample for this as well as other purposes becomes a serious problem.

Take, for example, the counties west of the Blue Ridge. From all that beautiful and interesting region between the Virginia line and Georgia, through which thousands of visitors would be delighted to drive every year—travel is practically excluded except along the railroads by the absence of good highways. The people living in these counties are becoming aroused to this fact; they see that good roads mean for them not only great saving in convenience, time and money in their own travel, but also great gain in the many thousands of dimes and dollars which these travellers would leave in every section through which they passed, and the addition of larger sums which many of them would invest in lands and homes. But how to raise in these sparsely settled communities money sufficient to build a costly system of highways is a problem not easily solved. It will never do to say that this cannot be done; for better public roads are an essential preliminary step in the development of this region. And what cannot be accomplished in a year for lack of sufficient means must be

accomplished by the united efforts of all classes of citizens during several years. In the achievement of this end in the sparsely settled and less wealthy counties, the following suggestions may be found of service:

Each county should raise by tax or bonds as large a fund as possible for use in road improvement; and the present general road law continuing in force, let property and labor (as should be the case) coöperate in this important work.

The money raised should be expended in the purchase of improved road machinery, and in the constant employment of a limited number of men who thus become trained in road building; and let the citizens living along the roads liable for road work be called out for this purpose, not all at once, but in limited numbers and at intervals (as suggested on p. 14).

The Boards of County Commissioners of the several counties should designate one or more prominent roads which shall be first improved, and add other important roads to this special list as rapidly as circumstances may permit. These special or "tax roads," as they are often called, should be selected both with reference to the convenience to the best markets for the people of the county, and to the attractions for the travelling public. The County Commissioners of each county should select an officer to be known as the Road Supervisor or Road Engineer who should personally superintend all the work of improving and maintaining these special roads. This officer should be selected with special care, and whenever possible the person selected should be a practical road engineer.

In the betterment of the main public thoroughfares, the several counties through which they pass should coöperate upon some plan arranged by the Boards of Commissioners of the several counties, in the working of their convicts on the road, in the purchase and use of improved road machinery, and in such other ways as may be deemed advisable.

In endeavoring to accomplish the greatest good with the least expenditure of money in this work, it will be found wise as described more fully in the next chapter: (1) To have the line of the entire road surveyed by a competent engineer, and the location changed in all places where the grade or road-bed can be greatly improved thereby; (2) the road should then be carefully graded, drained and rolled; (3) special sections of the road, where the soil in wet weather becomes quickly cut up into deep ruts, should be macadamized as rapidly as the funds will allow. After a few of the most important roads in each county have been treated in this way, the leading highway, on

which the work was first begun, may be macadamized throughout its entire length, and other important roads may be treated similarly, as circumstances permit or require. As illustrating the class of roads which it is here intended to designate as leading highways or roads of first importance in their communities, I may mention in the northwestern section of the State such roads as those from Sparta to Elkin, from Jefferson to Wilkesboro, from Wilkesboro to Lenoir, and from this latter road at Patterson a road *via* Blowing Rock to Boone; from Cranberry *via* Bakersville and Burnsville to Asheville, and from Bakersville to Marion. These roads with a few other connecting links — such as a road from Sparta *via* Jefferson and Boone to Cranberry — would open up this section of country and lead to its much more rapid development. Similar illustrations of leading highways can be supplied by the reader for every portion of the State with which he may be familiar.

In this connection it may also be wise to encourage the building of turnpikes by private companies. Many object to these roads because they have to pay toll-gate charges, but it is far cheaper to pay these nominal charges for the privilege of driving on a good road than it is to haul half loads and be severely jolted on a bad road for the privilege of traveling free. And if in our efforts to build good roads in thinly settled regions private companies are willing to coöperate in this way, their fair proposals should be welcomed. Subsequently, as the wealth of the community increases and the people are better able to do so, they can construct other roads or purchase these turnpikes on reasonable terms and open them to the public.

We have now in the State two striking illustrations, on a small scale, of the value of private enterprise in this connection. One is the "Shell road," extending from Wilmington to Wrightsville, which has for a number of years supplied a hard, smooth, excellent road both for those who drive in search of pleasure and those who with carts and wagons transfer various commodities between Wilmington and the seacoast at Wrightsville sound. It is eight miles long, and in width averages about twenty-one feet. It extends through a level region, sandy and marshy at intervals. Ditches were dug on both sides two to four feet deep for the purpose of drainage, the soil removed from the ditches being used to raise the road-bed. In the center of this road-bed a space twelve to sixteen feet wide was covered six inches deep with oyster shells taken from Wrightsville sound. Traffic soon ground the uppermost shells to a powder, which cemented the whole mass and gave a smooth surface on top. The attractiveness of the driveway has been increased by the planting of trees on both sides. The road was built

as a private enterprise by Wilmington gentlemen between 1875 and 1881 at a total cost of nearly $40,000.

The other of the two roads mentioned as built by private enterprise is the "Yonahlossee" road from Blowing Rock to Linville, which passes through the beautifully picturesque region along the southern slope of the Grandfather mountain, with a branch road extending to the top of this mountain. The main road is about twenty miles long, ten to fourteen feet in width, and was built at a total cost of about $10,000 by the Linville Improvement Company, on the plan projected by Mr. Hugh MacRae, then president and treasurer of the Company. Its route was surveyed and the road constructed under the supervision of Mr. S. T. Kelsey during 1890 and 1891. The larger part of the road surface is of loam and gravel (decayed siliceous gneiss); but along the steep slope of the mountain a considerable amount of excavation was necessary, the materials dug out of the mountain side being used to build up the lower half of the road; and in many places considerable quantities of rock had to be blasted out of the way and then used in the construction of culverts and supports for the road on the lower side. The road is an excellent one for summer travel and leads through one of the most beautiful and interesting portions of the mountain region of North Carolina. A somewhat similar turnpike is now being built from Boone to Cranberry by a private company; and it is to be hoped that others may be constructed in the near future.

Societies should be organized in the State for the collection and distribution of information with reference to the improvement of public roads; and agricultural societies already in existence should coöperate in this work. Institutions for higher education should give instruction as to the modern methods of locating and constructing roads. And it is gratifying to know that this is already being done by the State University and a few of the colleges.

CHAPTER THREE.

NOTES ON COMMON ROAD CONSTRUCTION.*

The subject of highways is naturally divided into their location, construction, and maintenance; but the first is so peculiarly the province of the civil engineer that it is not treated, save incidentally, in what follows. An instrumental survey of a proposed line is absolutely necessary to insure the lightest grades with (as far as possible) the shortest distance that can economically be allowed.

It will be seen from facts given below that the economy resulting from reducing grades is much more marked than that in saving distance. A very little calculation will show the enormous reduction, for the entire State, of the annual cost of hauling by wagons which may be made by a proper revision of the location of most of our roads by simply reducing grades on portions of the line, as a single steep grade on a long line limits the load which may be hauled over the entire distance. And those who have these matters in charge cannot appreciate too soon nor too clearly the fact that the proper laying out and construction of a good wagon road requires well-nigh as much good judgment and engineering skill as do the surveying and building of a railroad.

Assuming that this work will be entrusted to experts, and that the lines of road will be properly located, there follows in order the grading, proper construction of the road-bed, its drainage, and the improvement of its surface—all to be accomplished before the road can be thrown open for travel. As the subject of grading is sufficiently well understood, it was thought best to confine attention to the proper drainage of the road-bed, its proper shape, and the improvement of its surface, with remarks on maintenance, which subjects are not so well known and are generally ignored by the average road overseer.

The subjects thus chosen will be grouped under the following headings:

Drainage;
Earth Roads;
Telford and Macadam Roads;
Repairs of Broken-stone Roads;
Cost of Broken-stone Roads, and Repairs;
Gravel and Plank Roads;
Traction;
Grades.

*Prepared by Wm. Cain, Mem. Am. Soc. C. E.; University of North Carolina.

The most important of these subjects, especially for the heavier clayey soils, is drainage, and to this attention will first be directed.

DRAINAGE.

In Sandy Regions.—The first principle of successful road construction is proper drainage. In the "sand hills" this is not so evident, as the porosity of the sand effects the purpose which drains are required to do elsewhere; and as a rule, except in long, rainy spells, too much water passes through the pores of the sand, leaving it a loose, pulverulent mass, on which horses have to exert about double the pull required on an ordinary earth road, and about seven to eight times the pull required on a good Macadam or a plank road. The sandy road is really better when moist, unless it has a covering of stone or other material, as it generally accomplishes of itself more than is required for proper drainage.

But the principle is brought home at once, even in sandy regions, when a low, miry bottom or morass has to be crossed. Here "the first principle" is to dig deep and wide ditches on either side of the road, and raise an embankment with the excavated material as much above the natural surface as is necessary to ensure a dry road-bed. These ditches should discharge into natural channels ultimately, and it is preferable to have them, as well as the embankment, on a grade, when practicable.

In Clayey Regions.—The principle is the same on grades throughout the clayey lands. Ditches from two to three feet deep should be dug on either side of the road, whenever the material is a tenacious clay, but as there is danger of vehicles getting into these ditches and upsetting, they should either be separated from the roadway by a fence as shown in Fig. 10, or covered as is shown in Fig. 11, B, or what is better still, by the use of road machines the road surface should be graded from the center gradually down to the gutter, as shown in Figs. 9, 12, 16 and 21; and *in all cases* the centre of the road should be higher than the sides, so that the water will discharge readily into the drains. This rise at the centre, for earth roads, should be at least one-fortieth the width of road surface proper, and it should be increased on grades one or more inches, so that the water will not run along the road, but quickly reach the gutter by a diagonal path. In clayey soils the rise in the center should be as much as one-thirtieth of the width of the road; and where there there is no center drain the elevation is sometimes as much as one-twenty-fifth of the width.

Central Covered Drains.—Where the sub-soil is wet and full of springs, stone or tile drains are put in trenches, say eighteen to thirty inches deep, along the centre of the road (Fig. 9), connecting with cross drains at intervals of two hundred, three hundred, etc., feet, as the case may require. The drains may be made of any material, such as stone or brick, as well as tile, but the latter is preferable. Round tile is best, and if three inches in diameter is said not to cost (labor and materials included) more than twenty-two to thirty-five cents per foot. The

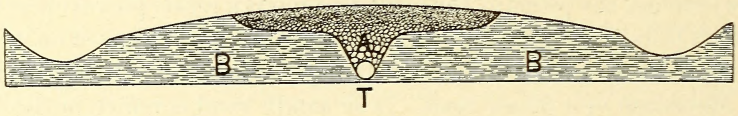


Fig. 9.—SHOWING CROSS SECTION OF DIRT-ROAD (B) WITH TILE DRAIN (T) IN THE CENTER FOR AIDING IN THE DRAINAGE OF THE SURFACE OF THE ROAD-BED IN CLAYEY SOILS.

A small quantity of straw may be placed just above the tile, and above this should be placed a quantity of coarse gravel or broken stone (A) and above this latter should be filled in with sandy loam or gravel as far as practicable. The depressions on both sides show the gutters or shallow ditches.

fall should be about two inches in ten feet, and not more than four inches in ten feet. The tile is made in lengths of one to two feet, and pieces of larger pipe fit on over the ends and connect the different lengths. The tile and covers should be carefully bedded in the earth throughout their entire length, to avoid breaking, and stones should be carefully packed around and over them to the top of the trench to relieve them of as much weight as possible. All "connections" should be made with Y branches, and silt basins are preferable at all junctions.

Diagonal Covered Drains.—These sub-drains are sometimes put diagonally across the road, meeting at a point at the centre, so as to form a V, with the point up hill. They should be placed twenty or thirty feet apart along the road in wet places.

Side Ditches.—In Europe, the ditches on either side of the road and running parallel with it, are often placed outside of the foot-paths (which are three to six feet wide), and a fence is built between the path proper and the ditch to keep the unwary from tumbling in. (See Fig. 10). In this case, the edge of the foot-path, which is about six inches above the gutter, is sodded, so that water falling on the road is conducted first to the open gutters, along which it runs without damage to the foot-path, and finally discharges by tile drains, about fifty feet apart, passing under the foot-path directly to the ditches. Where economy is desirable, the foot-paths may be omitted, and in fact the deep ditches are not necessary on grades as a rule, as

we see from analogy to the efficient drainage of railroad cuts. The common road may be drained in the same manner as a railway, by gutters or ditches on either edge of the road-bed, a foot to a foot and a half deep, the side of the cut forming one edge of the ditch. In very bad places, covered tile drains will be required under these gut-

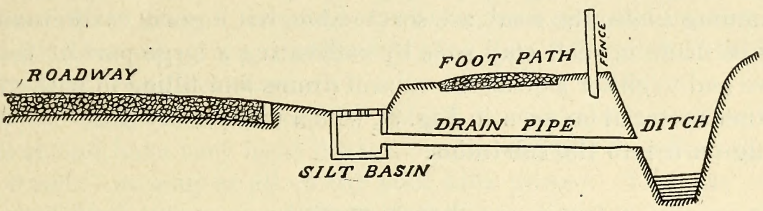


Fig. 10.—SHOWING CROSS SECTION OF A MACADAM ROAD WITH FOOT PATH PROVIDED, AS IN MANY PARTS OF EUROPE, FOR THE EXCLUSIVE USE OF PEDESTRIANS.

ters, say two or three feet deep. (See Fig. 11, B, page 50.) Where water is liable to run over the top edge of a cut, catch-water drains are made, running a few feet from the edge of the cut and parallel to the road, which should turn the running water away from the cut altogether to other channels or into the fields.

Culverts.—For culverts underneath embankments, large tile or stone drains are best. Wood should not be used for any kind of a drain, except temporarily, as it rots and invariably causes some accident. French drains, made by throwing in rocks into a trench in any order, are recommended by many, but the writer has found them a complete failure as a drain across an embankment, from silting up. It may take longer for the drain to close up or seal itself, in the case of sub-drains of common roads, as the water in them never runs with sufficient force to carry much silt, but in the end they will choke up and have to be replaced. Channels can sometimes be constructed in loose rock drains by selecting the rock for the covering of the little channel, but the tile drain is superior in every way and costs less than the stone drain.

The character of the road surface will often determine whether subsoil drains are required. Thus with a compact macadam covering the rain-water is conducted quickly to the gutters and comparatively little soaks through to form mud beneath the surface. A sand covering even is an aid, as it improves with moisture and protects the clay to a certain extent, as any excess of water can flow through it as well as over it to the gutters. On a clay road, however, the rain that falls is only in part carried to the gutters, even with a well formed surface. Much of the water soaks into the clay and is retained there and on

the surface together, especially when the road is cut up into ruts and holes, and no amount of side ditching under these circumstances can make a dry road-bed. As vehicles move over the soaked road, the tires cut into the wet clay and churn it up, so that it becomes worse and worse under travel and finally impassable from the mud, which can only dry off during a prolonged dry spell. The drains mentioned as running *under* the road are serviceable, but a good earth road can only be made in such clay soils by excavating a large part of the soil above and to either side of the subsoil drains and filling in with gravel or other material (as seen in Fig. 9), which will readily drain the water falling on it into the subdrains.

EARTH ROADS.

The common earth road containing much clay, can never be made satisfactory in wet weather; but by strict attention to the principles of drainage outlined above, it can be much improved and rendered a pleasant road to drive over during the larger part of the year. The usual method of constructing and repairing such roads in this State is an excellent example of how "not to do it." The road is worn or washed concave, so that water runs down its middle or remains upon the surface and soaks in, forming mud, and the repairs often consist of pine brush, sods, turf, or other perishable material, thrown into the holes and covered with earth; or, perhaps, rocks are thrown in when convenient, the result being a non-homogeneous surface, which is bound to wear into holes again. The road surface should be *homogeneous*, of

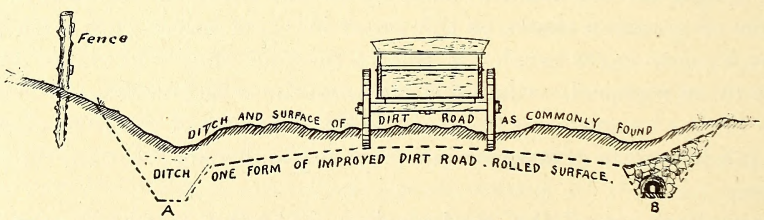


Fig. 11.—CROSS SECTION OF DIRT ROAD SHOWING COMMON FORM OF BADLY SHAPED SURFACE, TENDING TO BAD DRAINAGE AND PERMITTING WAGON WHEELS TO SINK INTO THE SOFT SURFACE. ALSO SHOWING FORM OF IMPROVED DIRT ROAD SURFACE WITH PLAN (A) OF AN OPEN DITCH ON ONE SIDE, AND PLAN (B) OF A COVERED TILE DRAIN ON THE OTHER SIDE. [From *Good Roads.*]

earth, or preferably of sand, gravel, shells, ashes, slag, &c., to render it as dry as possible, if the material of the road is clayey. In this case four inches of sand or gravel, well rolled, over only half the road, if there is not enough of it to cover the whole road surface, will make a wet weather road, the other half being suitable for dry weather.

If none of these materials are obtainable for covering the clay, Byrne recommends* the burning of the clay and spreading it on the road surface, which he estimates can be done at a cost for labor of about twenty or twenty-five cents per cubic yard; and he claims that when thus burnt, spread over the road surface and rolled, this clay makes a porous and serviceable road covering, easily drained. In clayey regions it is also well to keep all trees and shrubs large enough and near enough to shade the road cut away sufficiently to allow full access of sunlight for drying the road surface.

On sandy roads, clay may be added to the surface. The sand roads should have very light ditches—only enough to carry off the rain water—or none at all on the sand hills proper. The clay roads will need ditches from one to four feet deep on either side, as above explained, but with every precaution, in prolonged wet spells they are cut to pieces by the narrow tires of wagon wheels, and are barely passable. In the sandy regions of eastern counties it is possible in many places by deep plowing or ditching to bring up along the roadside a sufficient quantity of clay or loam which when mixed with the sand will pack and and greatly improve the character of the road surface.

In these sandy regions, further, it is well to leave trees growing close by the road, with their limbs overhanging it, so that the shade may retard the drying of the surface and the leaves and twigs which fall upon the road may improve the surface by preventing the movement of sand by the wheels. As an aid in the accomplishment of the same purpose, the growth of grass and other small plants on the unused parts of the roadway should be encouraged. And, according to Byrne,† "A coating of four inches of loose straw will, in a few days travel, grind into the sand and become as hard and firm a dry clay road."

Advantages of Wide Tires.—These tires should be two inches in width for the very lightest vehicle, up to six inches for those carrying the heaviest load per wheel. In France, "the freight and market wagons have tires from three to ten inches in width, usually from four to six inches. The four-wheeled freight wagons have tires rarely less than six inches, and the rear axle is about fourteen inches longer than the fore, so that the rear wheels run on a line about an inch outside of the line of the fore wheels. The varied gauge is also usually observed with cabs, hacks and other four-wheeled vehicles." In many other countries the width of tire is limited by law, and in the interest of good roads, the restriction should be imposed in this State, or a

*Highway Construction, p. 451. † *Ibid.*, p. 453.

bonus should be offered, or exemption from payment of road tax granted for a time to all persons who use these wide tire wheels.

"Foreseeing the objection which might be raised to the great cost of supplying vehicles now in use with wide-tired wheels, an ingenious inventor has placed upon the market an adjustable wide tire, which may be made of any desired width and so constructed as to fit any of the wagon wheels now in common use. These tires are made by the Richardson Manufacturing Company, at Bath, N. Y. Both iron and steel are used in their construction (as may be desired by the purchaser), and they seem to have given much satisfaction during the brief time they have been in the market."*

Width of the Road.—As to the *width* of roadway or the space traversed by vehicles, 12 feet is barely sufficient for two vehicles to pass, but 16 feet is ample and is the usual width macadamized in this country, though sometimes only half this width is so treated, the other half remaining an earth road. For three vehicles abreast, 22 feet is a minimum common width; whilst 30 feet is ample for four vehicles, and is rarely exceeded except on thoroughfares leading into very large cities.

Bad Location of our Common Roads.—Our common clayey roads are in their best condition, say six months in the year; they are tolerable three more months, and are wretched or impassable during the remainder of the year. They will never be improved without proper supervision of men trained to the business, and this fact is especially evident when we consider the bad location of most of them. Only a trained engineer can properly re-locate these roads on ground and grade suitable for the traffic. As to the great yearly loss from steep grades, which are often easily avoided, see the latter part of this chapter.

TELFORD AND MACADAM ROADS.

The movement for better roads was placed on an intelligent basis in England when in 1816 Macadam introduced the system of broken stone pavements which now goes by his name. In the construction of these roads the stones were broken by hand by men, women and children to sizes not larger than two inches diameter, and laid on a convex earth surface in layers of about three inches each, to a total depth of six to ten inches. In a few years 25,000 miles of such roads were constructed, the effect of which was to open up a great area of country, increase values enormously, lessen very materially the cost

* *Good Roads*, Vol. II., No. 2 (Aug., 1892), p. 92.

of transportation, and incidentally tend to the enlightenment and increased civilization of the people.

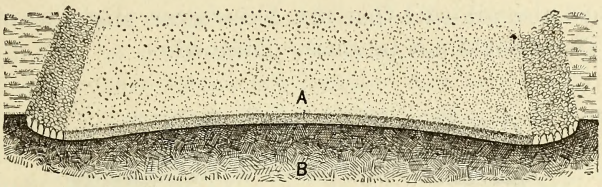


Fig. 12.—CROSS-SECTION AND TOP VIEW OF COMPLETED MACADAM ROAD WITH PAVED SURFACE GUTTERS AT SIDES. [From the *Century Magazine.**]

Macadam was followed by Telford, whose construction differed from his in adding generally a course of stones on a level earth foundation, seven inches in depth at the center and diminishing to three inches fifteen feet from the center (for a thirty-foot road), the stones to be set on their broadest edges and lengthwise across the road, the breadth of the upper edge not to exceed four inches in any case. All the

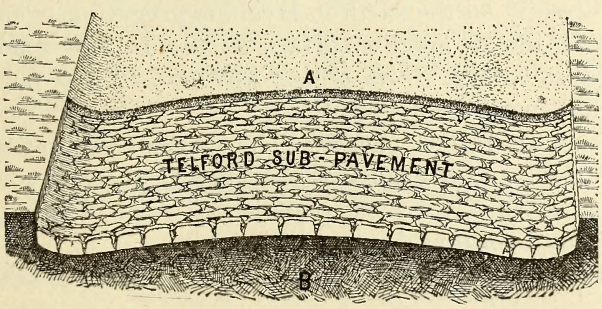


Fig. 13.—TOP VIEW AND CROSS-SECTION SHOWING METHOD OF CONSTRUCTING TELFORD ROADWAY. [From the *Century Magazine.*]

B is the rolled earth foundation on which is laid the sub-pavement as shown in Fig. 14. At A have been laid the upper courses of broken stone rolled into compact form, similar to that shown in the broken-stone layer of Fig. 12.

irregularities of the upper part of this Telford pavement are to be broken off by the hammer and the interstices filled with stone chips firmly wedged or packed by hand with a light hammer. On this foundation of large stones a covering of six inches of macadam, or stones of one and a half to two inches or less in diameter, is placed and rolled in layers as usual, so as to form a smooth, tight surface which will be agreeable to traffic and shed water readily. The object of the founda-

* Plates for Figs. 12, 13, 14, 18, 19 and 20, used originally in the *Century Magazine*, were supplied for this bulletin by the O. S. Kelly Co., of Springfield, Ohio.

tion is to distribute the pressure over as large an area as possible, so that the surface covering will not sink anywhere, and which should insure a smoother road surface than where no foundation course is laid. Telford also allowed that this foundation might be of gravel or sand when stone could not be easily obtained.

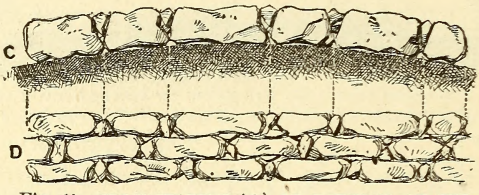


Fig. 14.—CROSS-SECTION (C) OF PORTION OF TELFORD SUB-PAVEMENT LAID ON ROLLED EARTH FOUNDATION, AND TOP VIEW (D) OF THREE PARTIAL COURSES OF SAME, SHOWING METHOD OF BREAKING JOINTS OF LARGER STONES AND WEDGING AND PACKING OF STONE CHIPS INTO VOIDS AND INTERSTICES. [From the *Century Magazine.*]

Macadam claimed that his roads of broken stone, made of small stones laid directly on the earth in layers aggregating from six to ten inches thick, made as good a surface as the Telford road, *when the earthen road-bed is well drained and well rolled;* and on this point experience has sustained his position.

Macadam versus Telford Roads.—The controversy over the relative merits of Telford and Macadam roads has waged continuously to this day. The opinions of the most experienced men in this country on the subject may be summed up as follows:

(1) Generally, either system makes a good road when faithfully carried out;

(2) The Telford system has a decided advantage in northern latitudes, where the frost penetrates the ground for several feet;

(3) On a road-bed which cannot be drained thoroughly, the Telford should be used;

(4) Where the soil is hard and gravelly, and not retentive of moisture, the Macadam pavement is a success anywhere; in fact, as far north as Bridgeport, Conn., a macadamized road only four inches thick on a dry foundation, has proved a great success;

(5) The Telford pavement generally costs more than a simple macadamized road, though the difference for equally good roads is not great, since the foundation course of the Telford road can be made of inferior and softer stones and the hard metalling reserved for the top. This surface metalling can be thinner than for a Macadam road;

(6) If the roads are kept in good repair, there is little difference in their wearing quality, but if not repaired, the thinner Telford coating will sooner wear out, and then the foundation course will make one of the worst stone roads imaginable, whilst the Macadam road, if properly constructed, will be good nearly as long as it lasts. The Telford foundation in this case is so much loss and is a useless expense.

(7) Wherever the drainage is not good, the Macadam wears into ruts more readily than a Telford road.

I have recently measured the depth of frost at Chapel Hill during the prolonged cold weather of January, 1893, when the thermometer fell to 0° F., and find it to be $8\frac{1}{2}$ inches. At and below this limit, it has been suggested that Macadam roads when properly drained, may be safely used, especially on steep grades where the water flows off quickly; hence for this State, it would seem that a Telford foundation is superfluous except in badly-drained soils. However, the proper construction of both systems will be given in what follows.

Cross Section.—It is now universally conceded by all, that the earthen road-bed on which the stone is laid, should not be level, as Telford recommended, but should be made parallel to the final stone surface which should always be higher at the middle than at the sides. The natural soil should be cut away to this curved form and all perishable matter removed and replaced with good earth.

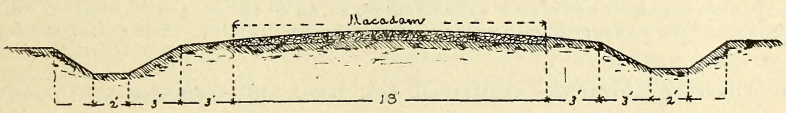


Fig. 15.—CROSS-SECTION OF MACADAM ROAD ON LEVEL GROUND, WITH SIDE GUTTERS OR DITCHES NOT PAVED. [From *Good Roads.*]

The middle of the road-bed, as consolidated by rolling and traffic, should be made higher than the sides in the following proportions of the width of the carriage-way from gutter to gutter:

Earth road, rise at centre	$\frac{1}{30}$ to $\frac{1}{40}$
Gravel road, rise at centre	$\frac{1}{50}$
Broken stone road, rise at centre	$\frac{1}{60}$
Stone blocks, rise at centre	$\frac{1}{80}$
Wood, rise at centre	$\frac{1}{100}$
Brick, rise at centre	$\frac{1}{20}$
Asphalt, rise at centre	$\frac{1}{80}$

For country roads, it will suffice to make the rise half-way from the inner edge of the gutter to the crown or middle of the road $\frac{5}{8}$, and at $\frac{3}{4}$ this half width of road from the gutter $\frac{7}{8}$ of the rise before given.

Thus for a finished broken stone covering for a road 16 feet wide, the centre rise is 3.2 inches, the rise at 2 feet from the centre is 2.8 inches and at 4 feet, 1.2 inches. This transverse section gives a slightly steeper slope nearer the centre than for the usual circular or parabolic section and is therefore preferable.

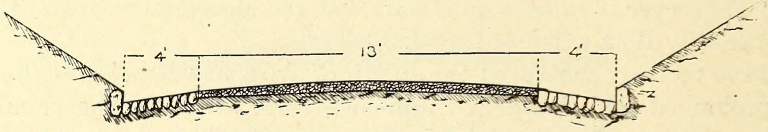


Fig. 16.—CROSS-SECTION OF MACADAM ROAD IN AN EXCAVATED ROADWAY AND ON A GRADE, WITH STONE PAVED GUTTER. [From *Good Roads.*]

Before the stone is rolled and consolidated by traffic, for a 16 foot roadway it is best to add at least 2 inches to the rise at the centre to allow for subsequent settlement; and further, on grades of over 5 feet in 100, an extra allowance of at least an inch is made to prevent the

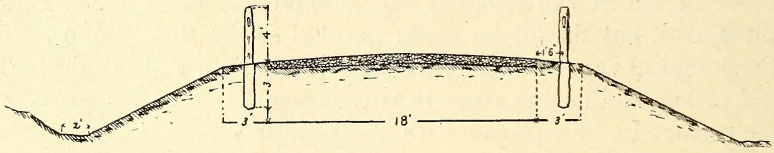


Fig. 17.—CROSS-SECTION OF MACADAM ROAD, ON AN EMBANKMENT OR FILL, BUILT UP WITH EARTH TAKEN FROM THE EXCAVATIONS, SO AS TO IMPROVE THE GRADE. THE FENCES ON THE SIDES PREVENT THE OCCURRENCE OF ACCIDENTS. [From *Good Roads.*]

water running along the centre of the road and washing the material away. A proportionate increase is to be made for other widths of roadway. On steep grades too, breaks in the grade are sometimes made every four or five hundred feet to give a rest to the horses.

Foundation.—The road-bed should be *thoroughly drained*, as already explained, and then *thoroughly rolled* to a firm surface. If beds of gravel or sand are convenient, it is well to use these on a clayey foundation, or if these are not to be had, to put a layer even of sandy loam 4 to 6 inches deep on the clay surface and roll it thoroughly. Sand makes a good foundation when confined, as it helps to distribute the pressure brought on a portion of it over a large area; besides it never makes mud and it prevents the mud below from working up among the stones. In country practice it is rarely used owing to the expense of obtaining it.

The Broken Stone Covering.—To build a Macadam road, about 4 inches of stone, broken by a crusher, so that the largest pieces have only a diameter of, say 1½ inches for trap rock, is spread uniformly

over the surface, just as it comes from the crusher, spawls, chips and dust included. This is rolled with a 2- to 5-ton horse roller or a 10- to 15-ton steam roller, so as to make the entire covering as tight and solid as possible, approximating to solid stone. If a light horse roller has been used, it is well to invite travel on the road for a while, as the wagon wheels consolidate a road better than the roller, though they do

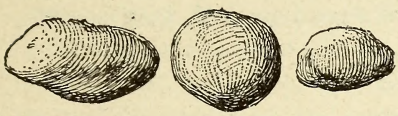


FIG. 18 ROUNDED PEBBLES AND SMALL COBBLESTONES TO BE CAREFULLY EXCLUDED FROM ALL MACADAM AND TELFORD ROAD-MATERIALS.



FIG. 19 SHOWING FORM AND SIZES OF STONE CHIPS COMMONLY USED FOR THE TOP LAYER IN CONSTRUCTION OF MACADAM AND TELFORD ROADS.

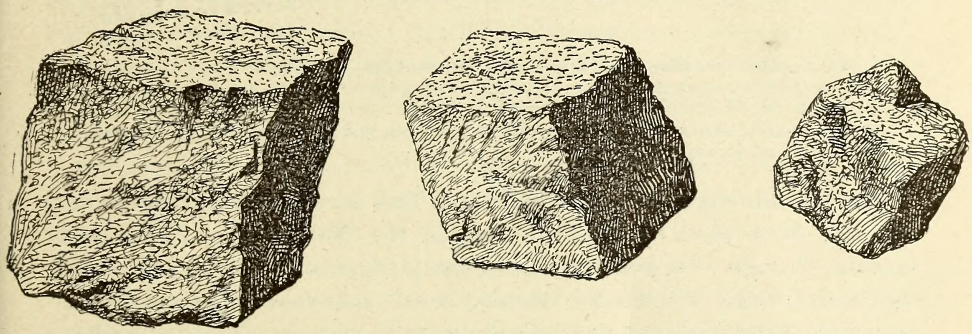


Fig. 20.—SHOWING ROUGH CUBE-SHAPED STONES OF PROPER SIZE AND FORM TO BE USED IN MACADAM AND TELFORD ROADS.—[From the *Century Magazine*].

In the "intermediate" courses of either form of construction slightly larger sizes may be employed; but in top courses it is always best to restrict the workmen to a maximum size stone not materially greater than that shown in the left of the figure.

so unequally and are apt to cause ruts unless the tires are wide. These ruts are to be worked out by the roller; then a thin coating of sand, gravel or screenings is laid and rolled, and another 4 inches of broken stone laid as before. It is advised to water each layer, add screenings and more water and roll until the water flushes the top. We have now a uniform depth of, say 6 inches of broken stone, as when rolled thoroughly the 8 inches original depth of stone is reduced to 6. Similarly we proceed for other depths.

It has been found by experience that a final depth of macadam of 6 to 8 inches is ample for light traffic and even 4 inches has been successful on a gravelly soil. To make a smooth road at once, a last top coat of screenings is used, but it costs $200 to $400 per mile and may be omitted if necessary, as the travel will eventually smooth and consolidate the surface.

Use of Binding Material.—Some engineers advocate the use of thin layers of clay or loam taken from the sides of the road as a substitute for the screenings for packing. It is put on each 4-inch layer of stone in turn, watered and rolled as before, and undoubtedly consolidates and brings the stones to a bearing very soon, as it fills the voids between the stones better than any other material. A light roller can consolidate the road with this packing, whereas it takes a 10- to 15-ton steam roller to consolidate a road packed with spawls, screenings or sand alone.

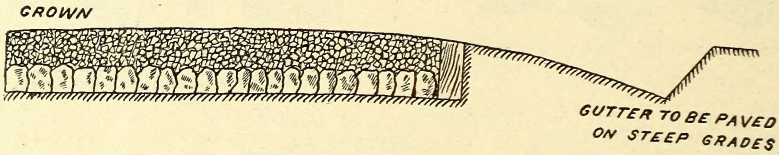
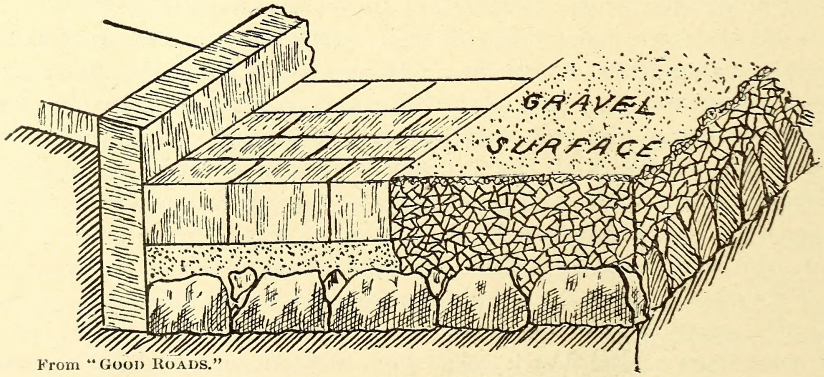


Fig. 21.—SHOWING CROSS SECTION OF ONE-HALF OF TELFORD ROAD FROM THE CENTER OR CROWN TO THE GUTTER ON ONE SIDE; THE LARGER STONES BELOW SHOW THE TELFORD FOUNDATION WITH THE CRUSHED STONE ABOVE. TO THE RIGHT OF THE STONE IS THE ORDINARY SOIL WHICH ON A LEVEL SURFACE OR GENTLE GRADES NEED NOT BE PAVED.

The French engineers have long used this earth packing, and it has recently been used by Mr. J. Owen on the New Jersey roads with success, though the general sentiment is against it, as it is claimed that heavy rains will wash it out and cause looseness in the mass. As the voids in broken stone are about one-half, and no amount of rolling can reduce them to less than one-fourth the total volume, some packing is essential, and if the screenings from the crusher are insufficient, clay or loam may be judiciously used in thin layers. Sand is said to be inefficient as a binder.



From "Good Roads."

Fig. 22.—TELFORD ROAD SHOWING A FOUNDATION OF LARGER STONES WITH SMALLER STONES WEDGED BETWEEN THEIR TOPS; ON THE LEFT IS A PORTION OF CURBSTONE AND GUTTER AS USED IN CITIES, AND ON THE RIGHT A PORTION OF THE BROKEN STONE COVERING OF THE ROADWAY WITH SURFACE GRAVEL. THE CURBSTONE AND GUTTER HERE SHOWN ARE TOO EXPENSIVE FOR USE ON COUNTRY ROADS.

The Telford Road.—In building a Telford road, the top surface of ground is made parallel to the final surface of roadway as with the Macadam road. On this, the foundation is made of large stones that may be of inferior quality to that used for the covering, as before described. On this foundation one-half to three-fourths inch of screenings of stone (or loam if necessary) is put on and rolled to prevent spawls working up; then the layers of macadam are put on as usual.

Use of both Macadam and Telford plans on same road.—An experienced engineer in road construction recommends on a grade of one in one hundred, six inches Telford foundation and four inches macadam on top; on grades of one foot in one hundred to five in one hundred, five inches Telford foundation and three inches macadam, and for grades of over five feet in one hundred he advises six inches macadam without any Telford foundation. Such thicknesses have given success even in bad soils. It is hardly advisable generally to build roads with only four inches of macadam covering alone, for although they have succeeded at Bridgeport, Connecticut, where the soil is sufficiently dry, yet in another case after doing good service for three years, a severe winter broke up miles of them; still they may be tried as an experiment in favored localities, on dry and gravelly earth beds, where they should prove the most economical of all good roads.

Misuse of Stone on Roads.—It should be clearly understood that broken stone of all sizes up to four or five inches, dumped in any way on an old road whose surface has not been prepared properly does not make a "macadamized road." It is a complete waste of money, and if such a system is pursued, will bring discredit upon this "move

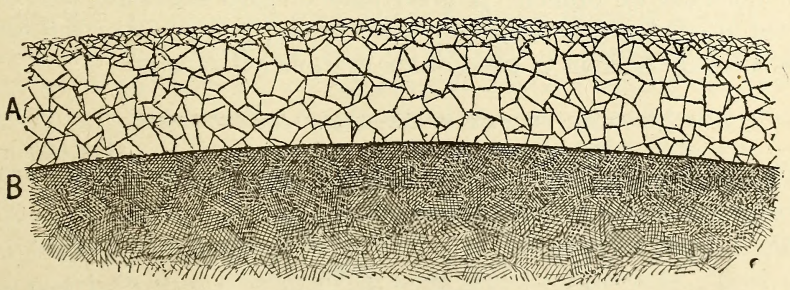


Fig. 23.—CROSS SECTION OF MACADAM ROADWAY (A) LAID ON COMPACT EARTH (B), MADE SOLID AND PERMANENT BY HEAVY ROLLING.

for better roads." Instead of the transverse section of the earth road being made convex as above explained, I have seen it made concave and dug into holes and the stone wastefully thrown in the holes and not consolidated or brought to shape, so that possibly much more

material was used and the road cost more than if an engineer had graded it properly and built a superior Macadam road.

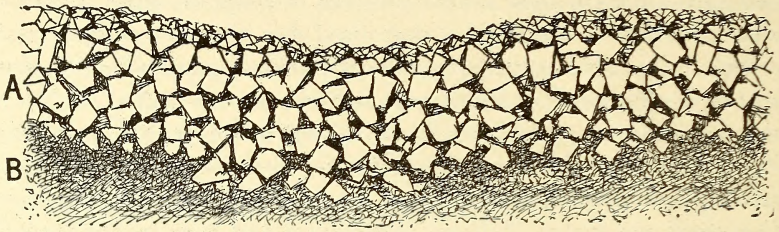


Fig. 24.—CROSS SECTION SHOWING WASTEFUL USE OF MACADAM MATERIAL (A) ON A ROAD SURFACE (B) NOT PROPERLY COMPACTED BY ROLLING, NOR THOROUGHLY DRAINED.

Let it be borne in mind that only experts in road making should have charge of the construction of our roads, and that there is no economy in employing a cheap man. Such a policy will certainly cost tens of thousands of dollars in the end and has proved a failure whenever tried.

REPAIRS OF BROKEN STONE ROADS.

As to *repairs*, the thick coverings last longest. An average road will last four or five years (unless very narrow) and for our country roads, should not cost for repairs over $100 to $150 per mile per year.

A road properly constructed should wear equally along its length and should be repaired by a coating of broken stone throughout, put on as before described. When ruts or holes are formed, it is proper to repair at once, but the daily tinkering and breaking up of a road in places for repairs, so universally followed by some, is not recommended by others. A good road of hard materials, well compacted, needs but few repairs for some years; but a road of soft materials can only be kept in good order by constant repairs.

COST OF BROKEN STONE ROADS AND REPAIRS.

The following table of cost of Macadam roads is taken from Byrne's "Highway Construction," (page 186):

Locality.	Thickness of stone. Inches.	Width of Pavement. Feet.	Method.	Cost per mile.
Bridgeport, Connecticut	4	18 to 20	Macadam.	$ 3,000 00
Fairfield, Connecticut	4	20	Macadam.	5,000 00
Franklin Township, N. J.	4	15	Macadam.	4,700 00
Plainfield, New Jersey	4 to 6	16	Macadam.	3,000 00
Kingston, Rhode Island	8	16 to 20	Macadam.	5,500 00

The cost is seen to vary with the depth of stone covering and the width of the road. Thus, for a depth of stone of four to six inches, the cost for a sixteen foot road is at least $3,000 per mile; whereas, for the same width, but with eight inches of stone, the cost is $5,500. The proximity of the stone of course largely influences the cost. If in places the plan be adopted of having only one half of the sixteen foot road macadamized, leaving the remaining half to serve as a dirt road, the cost per mile of the four inch Macadam road might be reduced to $1,500 or $2,000 per mile.

The Most Economical Width of Macadam Road.—As stated on page 52, and as indicated in the above table, the width of the macadamized part of the road, as generally adopted in the United States, is 16 feet, but varies from 15 to 20 feet. In Austria the macadamized space ranges from 14 1-2 to 26 1-4 feet, in France from 16 to 22 feet, while in Belgium the regular width is only 8 1-4 feet. The full width of the roads, however, in different countries, and even in the same country, ranges from 26 to 66 feet, portions of this space being occupied by the foot-path, ditches and the macadamized wagon-way—and in some cases a dirt road by the side of the latter. As the cost of the Macadam road varies with the width and thickness of the broken stone covering, this should be as narrow and thin as may be consistent with the usefulness and durability of the road. The 8-foot Macadam road has proved fairly satisfactory in Belgium, and in Mecklenburg county of our own State, where it is now being tried. But on account of its narrowness the wagon wheels must always run in the same places, and with our narrow American tires ruts are cut with comparative rapidity. This road is too narrow for vehicles to pass without one of them leaving the macadamized part, and in so doing there is always a tendency to break down the latter on its edges, to bring quantities of mud on to the road surface; and in wet weather leaving the macadamized part with a loaded wagon often means to sink into the mud on the roadside. Consequently, as far as possible, the Macadam road should have a width of not less than 14 feet, so as to allow two vehicles to pass, and especially is it important to do this on roads on which the soil is rotten and becomes easily cut up in bad weather; also on mountain roads, where the tendency to wash away the dirt road is so strong, it is better to macadamize the full width of the road (14 or 16 feet). And it should be borne in mind in deciding as to the width of space to be macadamized, that a Macadam road 14 feet wide and 5 inches deep costs very little more than one 8 feet wide and 8 inches deep, and is far more satisfactory.

Cost of Repairs.—The cost of keeping the road in repair per year varies with many conditions, the traffic being the principal. Thus in London the cost of maintenance varies from 6 to 62 cents per square yard; in Paris it is about 45 cents, and in Boston 50 cents.* It must be borne in mind that the cost of labor in Europe is less than in the United States. The country roads cost less for repairs; thus in Belgium it is 6 to 10 cents per square yard; in France 1 to 10 cents; in Bavaria $116 per mile. From the experience in this country it would seem that repairs for highways should not cost more than 3 cents per square yard, or for a road-bed of 16 feet in width, $176 per mile. It has been given lower than that by some and higher by others, but experience in New Jersey would indicate about $150 per mile per year including renewals every 5 years. An average estimate, therefore, for a macadamized road 16 feet in width and 6 to 8 inches thick would be about $4,000 to $5,000 per mile for construction and about $150 per year for maintenance — the interest of $2,500 at 6 per cent. For roads of less width, the cost is proportionately decreased, though not in a direct ratio.

Where the stone is near at hand and the other conditions favorable, roads 16 feet wide have been built at $3,000 to $4,000 per mile, and it is to be hoped that with cheaper labor most of our roads can be built at the lower rate; but it is safer to take the larger figures in making our preliminary estimates.

Some memoranda of average cost of various items, etc., may be of interest here. They are taken from Byrne and other sources.

Rollers.—A 2-horse roller weighing 2 tons will cost $175; a 10-ton steam roller costs $3,500 to $4,000. The yearly maintenance of the latter runs from $1,300 to $2,000, when it is used constantly.

A steam roller finds difficulty in surmounting a grade of 1:6, but none on a grade of 1:14. It can roll 500 to 3,000 square yards per day; average in England of 42 towns, 1,105 square yards. In England the cost of rolling is from 1 to 2 cents per square yard ($60 to $120 per mile for a 16 foot road-bed); in the United States, 1 up to 14 cents per square yard.

Loam put on and rolled will cost from $30 to $50 per mile. The rolling of the stone covering should start from the sides and be continued "until the stones cease to creep in front or sink under the rolls, and the surface has become smooth and firm."

Stone Crushers.—These cost, average size, and including engine, boiler, etc., $2,500; expenses of operating, per day, $15 to $27.

* A road 16 feet wide contains 5,867 square yards of surface in one mile.

Cost of Quarrying and Crushing Stone.—The following gives the cost of quarrying and crushing, etc., per cubic yard at Hartford, Conn.: Quarrying 70c., crushing 35c., carting to breaker 25c.; total cost crushed at quarry $1.30, and delivered on streets, $1.80. The haul was not over two miles.

Amount of Crushed Stone Required.—A well rolled road covering contains from 70 to 80 per cent. of stone. Adding 25 per cent. for compression, we have the number of cubic yards of broken stone required in a mile as follows:

Depth in Inches.	Width of Pavement.		
	8 Feet.	16 Feet.	24 Feet.
Four inches	645	1290	1935
Six inches	968	1935	2903
Eight inches	1290	2580	3870

GRAVEL ROADS.

Macadam is said to have deduced his principles of construction of broken stone roads from noticing how wheels sunk in and ploughed up a gravel road in consequence of the roundness of the pebbles.

Rounded pebbles should never be used for gravel roads except from necessity, but where an abundance of angular stones can be found near the line of the proposed road, a good and cheap gravel road can be made exactly in the manner hitherto detailed for broken stone roads. As a rule pit gravel contains too much earth, from which it should be partially screened; but a certain amount of ferruginous clay is desirable and causes the gravel to set and become hard as soon as it is exposed to the action of the atmosphere. The gravel and clay mixed are put on in layers of say three inches, then watered and rolled by a 2- to 5-ton horse roller, when other layers can be added in a similar manner. No gravel larger than two inches diameter should be used, all larger stone should be broken. Such roads are good in dry or slightly damp weather, but in rainy periods or very dry weather the clay looses its hold and the road becomes muddy or dusty, as the case may be, and looses its coherence. Such roads, however, are vastly superior to earth roads and should be constructed where suitable gravel is abundant.

Cost of Gravel Roads.—They have been constructed at Richmond, Virginia, for fifteen to twenty cents a square yard, and at Haverhill,

Massachusetts, for twenty-five cents per square yard, or say from $900 to $1,500 per mile for a roadway sixteen feet wide.

In Illinois, for a roadway twelve feet wide, the gravel being twelve inches deep at the middle and nine inches at the sides, the cost was $900 per mile; in Boston, Massachusetts, the cost was seventy-five cents a square yard, or say $4,500 per mile for a sixteen foot roadway.

Plank Roads.—The construction of plank roads in the timber regions of our State is well understood. The track is usually made eight feet wide, with a dirt road of eight to twelve feet alongside; sills four by twelve inches and fifteen to twenty feet long are laid parallel to the centre line of the road and about four feet apart. They are laid flatwise and firmly embedded in the ground and "break joints." The plank covering, laid at right angles to the sills, consists of boards eight feet long, nine to twelve inches in width and three inches thick. They are placed on the sills, but are not spiked to them and are so arranged that every three or four project alternately on each side three or four inches beyond those next to them, so that vehicles can readily pass from the earth road to the plank road. The slope of the planks should be three inches in eight feet towards the ditches.

The cost per mile varies from $1,000 to $2,400 exclusive of extra earth work, bridges, culverts, etc., and the planking lasts about eight years when well built and cared for.

Possibly, in the long leaf pine regions where timber is plenty and rock scarce, plank roads are the cheapest and best that can be constructed.

Tractive Force.—The pull of the horse on the vehicle or force required to overcome the resistance to motion, is called the tractive force and is expressed in the following table as a part of the gross weights of wagon and load for various road surfaces, at velocities corresponding generally to a pace or a trot. The table is taken from one compiled by Mr. Rudolf Hering.

Sand	$\frac{1}{5}$
Sandy road	$\frac{1}{12}$
Loose gravel	$\frac{1}{7}$
Co mmon gravel road	$\frac{1}{16}$
Hard rolled gravel	$\frac{1}{30}$
Ordinary earth road	$\frac{1}{10}$
Hard clay	$\frac{1}{20}$
Hard and dry earth road	$\frac{1}{22}$ to $\frac{1}{30}$
Cobble stone	$\frac{1}{8}$ to $\frac{1}{15}$ to $\frac{1}{30}$
Macadam, little used	$\frac{1}{16}$ to $\frac{1}{23}$
Macadam, ordinary	$\frac{1}{25}$ to $\frac{1}{35}$
Macadam, best	$\frac{1}{35}$ to $\frac{1}{70}$

Good Belgian block	$\frac{1}{30}$ to $\frac{1}{35}$
Planked roadway	$\frac{1}{40}$ to $\frac{1}{57}$
Asphalt	$\frac{1}{133}$
Granite tramway	$\frac{1}{166}$
Iron	$\frac{1}{200}$

Load a Horse can Draw on Different Surfaces.—Hence, if we call the load a horse can draw on an iron track 100, the loads he can pull on other road surfaces (taking average results) will be represented as follows:

Iron track	100
Granite tramway	83
Asphalt	67
Plank road	30
Best stone blocks	30
Macadam, good	18
Cobble stone	10
Gravel road	8
Earth road, common	6
Sand	3

Cost of Transportation.—So many elements enter into the cost of transportation on various road surfaces that it is impossible to estimate the saving in improving the surface except very approximately. As an illustration, however, let us take a level earth road twenty-five miles long on which an average horse, moving at two and one-half miles per hour, will make a day's journey in ten hours. The horse can easily exert a horizontal pull of one hundred pounds on the wagon for this rate and time.

Let us suppose that the traction on the earth (hard clay) road is one-twentieth the gross weight of wagon and load; whereas, if the surface is macadamized, the traction will be just half or one-fortieth of the total load. Further, we shall suppose that fifty two-horse wagons go over the road daily for three hundred days in the year, the yearly cost of one hundred horses and fifty drivers being as follows:

One hundred horses at 50 cents per day	$ 50 00
Fifty drivers at $1.00 per day	50 00
	$ 100 00

For one year (of three hundred working days) this would amount to 300×$100=$30,000.

As the traction on the earth road is $\frac{1}{20}$, and one horse exerts a pull of 100 pounds all the time, the gross load carried by two horses on the earth road is 20×200=4,000 pounds=2 tons. Assuming the two

horse wagon to weigh half a ton,* this leaves the net or paying load carried as a ton and a half. With a Macadam surface, however, (the traction being $\frac{1}{40}$) the two horses attached to the wagon can drag a gross load of $40\times200=8{,}000$ pounds=4 tons. Subtracting from this the weight of wagon ($\frac{1}{2}$ ton), we have the net load=$3\frac{1}{2}$ tons or $\frac{7}{8}$ times the net load carried on the earth road. Therefore $\frac{3}{7}$ of the wagons originally employed can haul the same tonnage. Thus 50 wagons at $1\frac{1}{2}$ tons (net load)=75 tons daily; $\frac{3}{7}\times50$ wagons at $3\frac{1}{2}$ tons (net load)= 75 tons daily. We thus find that to haul the same tonnage over the Macadam road, only $\frac{3}{7}$ of the horses, drivers, etc., used on the earth road are required, so that the yearly saving on this 25 miles of road by macadamizing it would be $\frac{4}{7}$ of \$30,000=\$17,143—interest on \$285,717 at 6 per cent. Clearly it would pay the people who travel over this road to borrow the sum of, say \$100,000, and with this macadamize the 25 miles at once; and in nine years the annual savings will have paid the interest and paid off the principal.

The saving is even greater than has been estimated on account of extra wear and tear of wagons and harness on the earth road and its impassable condition during a part of the year, as to which, see Chapter II.

GRADES.

Where *grades* are encountered, the ratio of the relative resistance due to gravity to the resistance on a level road is greater the smoother the road. The writer has computed the following table to show this. The load which can be hauled on a level, for the kinds of road given, being called 100, the loads which may be hauled on various grades are as follows:

Grade.	Ordinary Earth Road, Traction one-tenth.	Very good Earth Road, Traction one-twentieth.	Good Macadam Road, Traction one-fortieth.
Level	100	100	100
1 foot in 100 feet	91	83	71
2 feet in 100 feet	83	71	55
3 feet in 100 feet	77	63	45
4 feet in 100 feet	71	55	38
5 feet in 100 feet	66	50	33
10 feet in 100 feet	50	33	20
15 feet in 100 feet	40	25	14

*The two-horse wagons used in the hilly country around Chapel Hill weigh from 800 to 1,400 pounds, the average of 20 weighings being 1,075 pounds. The net load carried varies from 478 to 2,020 pounds, the average being 968 pounds. The one-horse wagons weigh from 400 to 640 pounds, average 551 pounds, and carry net loads of 190 to 630 pounds, average 416 pounds. These figures were kindly furnished me by Mr. A. S. Barbee.

Thus on a rise of 10 in 100, a horse can pull on an ordinary earth road $\frac{50}{100}$ or $\frac{1}{2}$ the load he can draw on a level; but on a good macadamized road he can only draw on this grade, $\frac{20}{100}$ or $\frac{1}{5}$ the load he can draw on the level. It follows from this example, or generally from the table, that it is much more important to reduce grades on any road that is to be macadamized than it is to lighten the grades on a common earth road whose surface is not to be improved.

It was assumed in the table above that a horse can exert the same pull on a grade as on a level, which is not true, especially for the steeper grades; so that for the latter, the above figures should be somewhat less. This is due to a horse's anatomical formation and great weight, for although a horse on a level is equal to 5 men, on a rise of 15 feet in 100 he is not as strong as 3 men, and finally the grade may become so steep that he can barely pull his own weight up it.

A horse can, however, for a short time exert double his usual force (or even more for very short distances), which will take him over hills giving double the resistance on a level. His tractive force also varies with the velocity, being for an average horse working 10 hours a day at 4 miles per hour 60 pounds, at $2\frac{1}{2}$ miles per hour 100 pounds, and at 1 mile per hour 250 pounds. It is also proportionately greater when he works a less number of hours each day.

On a macadamized road where the traction is $\frac{1}{35}$ of the load on a level, the horse will have to exert double his force to overcome a grade of one foot in thirty-five, which he is supposed to be capable of doing. This grade likewise being "the grade of repose," a vehicle can be driven down it at a good rate, say twelve miles per hour, without increased speed due to gravity. Hence, whether viewed as an ascent or a descent, this grade should be the *maximum* (when practicable) under the conditions assumed. Similarly a grade of one in forty is the maximum when the traction on a level is $\frac{1}{40}$ of the load.

The *minimum* grade should not be less than half a foot in a hundred, or better, one in a hundred, for purposes of drainage, giving a full and free flow to water in the gutters and ditches.

Steep Grades add Greatly to Cost of Transportation.—As grades are frequently much greater than one foot in thirty-five, it is well to give an example showing the loss a *single steep grade, on a line say twenty-five miles long, or a day's journey, will entail.* To take an extreme case, suppose the hill to rise one foot in ten, when traction on a level is $\frac{1}{35}$ of the load or 57 pounds per ton of 2,000 pounds, corresponding to an average macadamized road. The extra force required on the grade is of

2,000 pounds=200 pounds, which added to 57 gives 257 pounds, the horse must exert on the grade for each ton hauled. Half of this is 127, so that if the hill is not too long for the horse to exert double his usual force in overcoming it, the ratio of the gross load he can draw on the grade to that he can draw on a level is 57:127.

Let us suppose (as in a previous example) that 50 two-horse wagons pass over the hilly road 300 days in the year at a cost of $30,000 per year. If a horse can exert a pull of 100 pounds at 2½ miles per hour for ten hours, then as we have taken the traction at 1:35, the horse can pull a gross load of 35×100=3,500 pounds on the level portion of the road. Therefore,

Two horses can pull a gross load of	7,000 pounds.
Weight of wagon assumed to be	1,000 pounds.
Net load on a level	6,000 pounds.

On a grade of ten feet rise in one hundred feet, the two horses exerting double their usual strength can draw, as we have seen,

$\frac{57}{127}\times 7{,}000$	3,142 lbs.
Weight of wagon	1,000 lbs.
Net load on grade	2,142 lbs.

This is but little over a third the net load (6,000 lbs.) drawn by two horses on a level. For convenience, take it as one-third.

We thus see that it will take three teams on the grade to haul the same *net* load as one team on the level portion of the road. The *extra cost* in one year, due to the grade limiting the load over the whole twenty-five miles of road is thus two-thirds of the cost over the line with the hill on it, or ⅔×$30,000=$20,000—the interest on $333,333 at six per cent. Any amount less than this can be economically expended in getting a level route around the hill if the length or cost is not greatly increased.

It is supposed here that the hill is at least 400 to 600 feet long (as a horse can exert more than double his strength on less lengths) but not over a mile, so that the horse can continually exert double his usual strength over the entire grade. The net tonnage is taken very small—only 50×2142=107,100 pounds or about 54 tons a day at a cost of $100 or $4 per mile (wear and tear omitted) or 7.4 cents per ton per mile. On the perfectly level road, the cost is one-third of this, or 2.5 cents per ton per mile, certainly a very low estimate.

If the *distance* has to be increased 1 mile to avoid the hill, suppose the cost of this extra mile to be $10,000 and the yearly maintenance

$150 per mile, the interest of $2,500 at 6 per cent; a total of $12,500. As the cost of hauling the net load of 54 tons on the road with the grade is $30,000 per year, the cost of hauling the same net tonnage on the level road is one-third of this, or $10,000 per year on 25 miles, or $400 per mile—the interest of $6,666 at 6 per cent. Add to this the cost of building and maintaining the extra mile ($12,500) and we have $19,166 in all as the principal to provide for the first cost, maintenance and cost of operating the extra mile, against $333,333 to expend in avoiding the hill. This example suffices to illustrate how a very large amount can often be judiciously expended in avoiding some steep hill, which limits considerably the loads carried over the rest of the line, even when the latter is not level, as was supposed to simplify the calculations. In most cases, however, the road line can be changed at moderate cost.

Many of our roads were originally only bridle trails, or at least were located without reference to economy in hauling heavy loads by wagons. Consequently most of them go directly over hills, without any attempt at securing a gentle grade even when one is perfectly practicable. As we have seen, the heaviest grade limits the load over the whole road to what can be hauled up the steep grade; besides this, all other hills giving lesser grades increase the cost of hauling; so that many changes in the location of our country roads, particularly if they are to be macadamized, are imperatively demanded. On such work only a trained engineer is competent and should be employed. Such a man can earn a hundred fold his salary in one year when the saving to all concerned is considered.

The endeavor has been made in what precedes to give some of the principles of highway construction which it seemed desirable should be *generally known*. Let the move for "better roads" be organized carefully and judiciously and attend first to a revision of the location of country roads, particularly in the hilly country; then must follow the improvement of the surface by macadamizing or otherwise, the *proper* construction of which should be *rigidly insisted on*.

CHAPTER FOUR.

TOOLS AND MACHINERY EMPLOYED IN ROAD CONSTRUCTION.

The following brief notes on the tools and machinery employed in the construction and repair of roads are intended only to give such general information as may be useful to county commissioners, road supervisors and others who may be interested in the subject. As new and improved types of tools are likely to be placed on the market at all times, and as prices change more or less every year, it will be well for all persons desiring to purchase such machinery and tools to correspond directly with several manufacturers or large dealers, and also with different road engineers about them before doing so. The facts here stated are taken in part from Byrne's "Highway Construction," and "Good Roads," in which there will be found a full and illustrated treatment of the subject. When a lot of tools and machinery is ordered at one time doubtless the manufacturers will cheerfully send along an agent to show how the machines are put together and operated.

Tools Used in Grading.—A large part of the work of road improvement, after the location has been settled, will be found to consist in the proper grading and drainage of the dirt road-bed. In connection with the building of railroads so large an amount of work of this kind has been done that improved machinery has been extensively and economically used, and in the treatment of our public roads it will be wise to adopt similar methods. The following list of tools will be found useful in clearing, grubbing, ditching and grading:

Axes, price per dozen	$12.00 to $15.50
Bush-hooks, handled, per dozen	17.00
Grub-hoes, per dozen	11.00 to 17.00
Mattocks, per dozen	15.50 to 18.00
Shovels, square-pointed, per dozen	7.00 to 13.00
Shovels, round-pointed, per dozen	7.25 to 13.50
Picks, per dozen	10.75 to 22.50
Spades, per dozen	13.25 to 14.50
Hoes, per dozen	13.50
Wheelbarrows, per dozen	20.00 to 52.50
Plows for road work, each	20.00 to 60.00
Scrapers, drag, each	12.00 to 15 00
Scrapers, wheel, each	50.00 to 70.00
Carts, each	65.00 to 75.00
Road machines, each	100.00 to 300.00

Plows.—Plows of special forms adapted to this work are used extensively in road improvement and are manufactured by several establishments. They are known under different names, such as "road-plows," "grading-plows," "township-plows," etc., and vary in form according to the character of work they are intended to do.

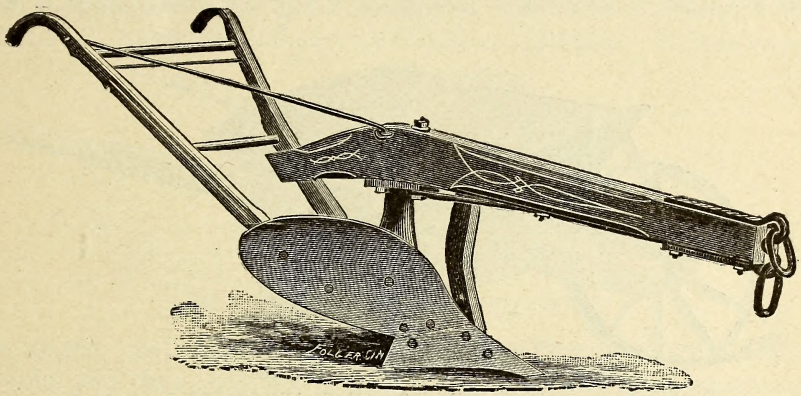


Fig. 25.—TOWNSHIP OR BREAKING PLOW.

They are made of the strongest wood and wrought iron, with steel points, and are pulled by two or four horses. They weigh from 100 to 300 pounds and cost from $20 to $60 each. The accompanying illustration of the "Township" or "Breaking-plow" shows their general characteristics. In rocky soil it will be found best to remove the knife to prevent its edge becoming dulled by the stone. This plow is

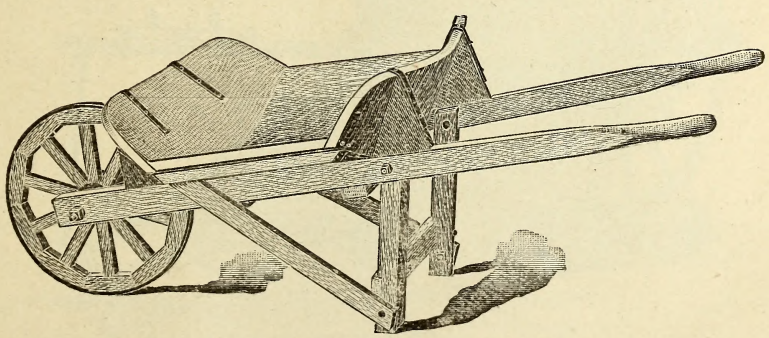


Fig. 26.—WHEELBARROW OF OAK WOOD.

of light draft, requiring two horses in loam soils and four horses in heavy clay soils. It is not intended for turning the soil but cuts a furrow 10 inches wide and 6 to 11 inches deep, and weighs about 120 pounds. These road-plows are manufactured by the American Road

Machine Company, Kennett Square, Pennsylvania; the Kilbourne & Jacobs Manufacturing Company, Columbus, Ohio, and other companies.

Wheelbarrows.—The wheelbarrow shown in Fig. 26, constructed of wood, is one of the forms most commonly used in earth work. Its capacity ranges from 2 to 2 1-2 cubic feet, its weight is about 50 pounds and its price is about $20 per dozen. Fig. 27 shows another form

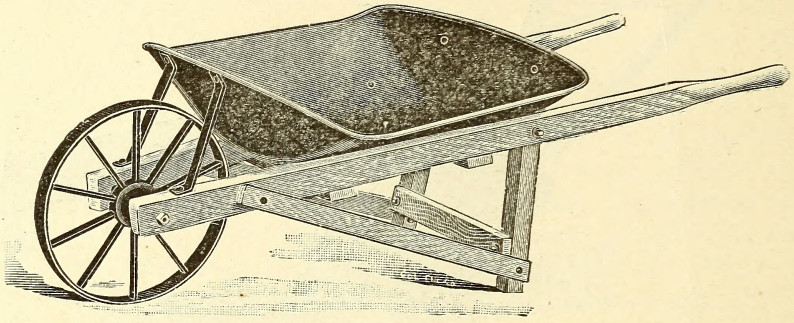


Fig. 27.—WHEELBARROW WITH IRON WHEEL AND PRESSED STEEL TRAY.

of wheelbarrow with frame of oak, wheel of iron and tray or bowl of pressed steel. Its capacity ranges from 3 1-2 to 5 cubic feet, and its price from $5.50 to $7.50 each. While costing more it will be found to be much more durable than the all-wood barrow.

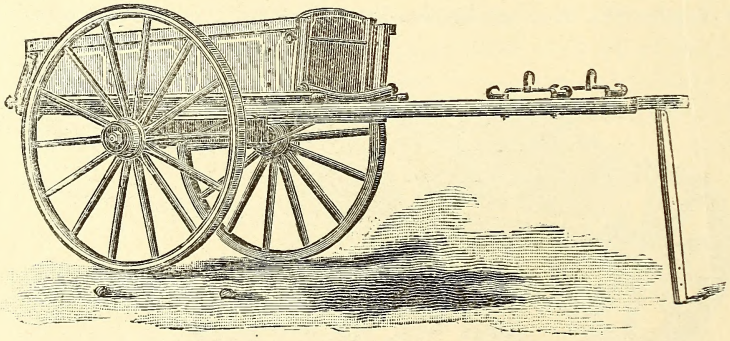


Fig. 28.—ORDINARY EARTH CART.

Carts.—Fig. 28 shows a form of cart ordinarily used in hauling earth and other materials. These carts have broad-tired wheels to prevent their sinking into soft earth, and the body is so balanced that when the load is evenly divided there should be no great pressure on the horse's back. The average capacity of these carts is 22 cubic feet,

but it is more convenient to have them large enough to hold an even cubic yard of earth. The average weight is about 800 pounds, and the price $65 to $75.

The Austin Dump Wagon (Fig. 29) is claimed to be a great improvement on the ordinary cart, as it can be dumped more quickly and easily. Its capacity is from 35 to 45 cubic feet. It is manufactured by the F. C. Austin Manufacturing Company, Chicago. It is an expen-

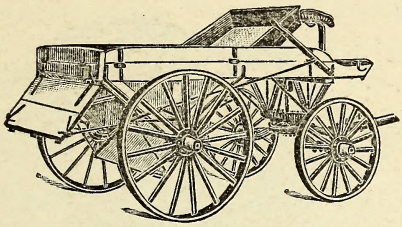


Fig. 29.—THE AUSTIN DUMP WAGON, DUMPED.

sive wagon, costing $135; but being of iron throughout, it is quite durable, and those who have used it claim that it is an economical machine even at this price.

*Scrapers.**—"These are great labor savers in many places, and are made in a variety of forms. The best are of solid steel, being lightest, strongest and most durable, and in the end the cheapest. In many soils a good steel scraper can be used even though ploughing has not been done, but the plough is always an important aid in loosening the soil, no matter what method is adopted for its removal. The common solid steel drag scrapers will carry from three to seven cubic feet of

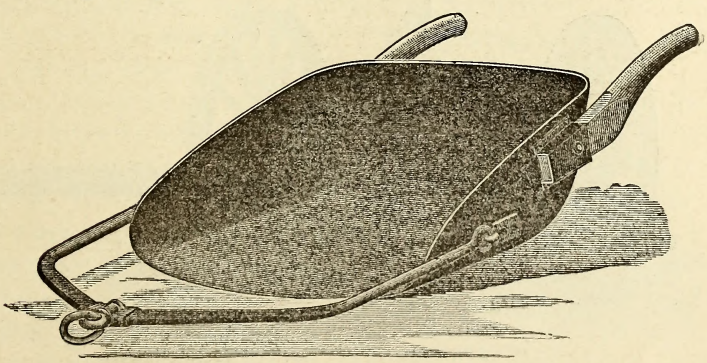


Fig. 30.—DRAG SCRAPER IN POSITION FOR LOADING.

earth, the largest size being generally employed for longer hauls and where the earth is to be carried away on a down grade. A scraper having a capacity for about five cubic feet is best for ordinary carting,

*I. B. Potter, in "Good Roads," Vol. I, (1892) pp. 333-'5.

while if only one horse is employed, and light work only is intended, the scraper carrying three feet will be sufficient." The scrapers with two strips or runners on the under surface, as shown in Fig. 31, have a lighter draft, and those with round edges on the bottom, like the one here illustrated, last longer.

"In the employment of a scraper you will find it necessary in most cases [in using scrapers having a capacity of 5 to 7 1-2 cubic feet] to

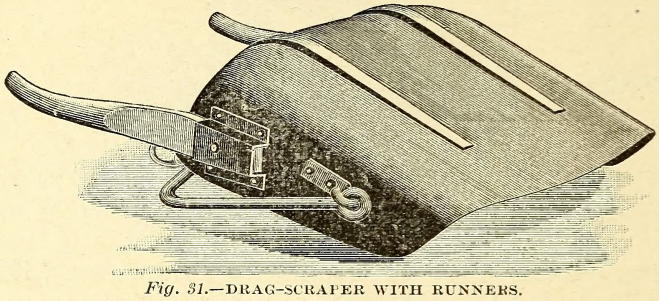


Fig. 31.—DRAG-SCRAPER WITH RUNNERS.

use a team of two horses, and if the haul is short the size of the scraper should be made correspondingly smaller, because the filling of the scraper will be more frequent, and this portion of the work will be very severe upon your team. Scrapers are largely used in the handling of earth where much work is to be done, and they have an advantage in cheapening the cost of the work. Trautwine computes that by the use of a drag scraper in light soils, the cost of handling earth per cubic

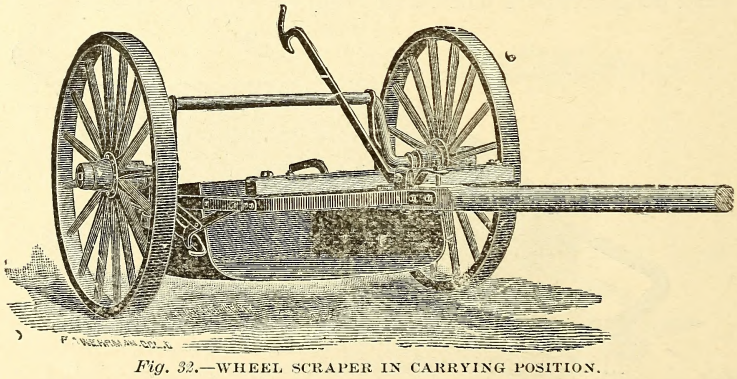


Fig. 32.—WHEEL SCRAPER IN CARRYING POSITION.

yard (not including contractor's profit) varies from 5 1-2 to 12 cents per cubic yard where the lengths of haul vary from 200 to 250 feet, including the spreading of the material in places, while the same cost under shorter lengths of haul, where the earth is 'wasted,' varies from 4½ to 11 cents.

While drag scrapers are quite satisfactory on short hauls, for long hauls wheeled scrapers are coming into general use. "They are made to carry from about twelve to seventeen cubic feet of earth when 'even full,' and mounted on wheels having broad tires to prevent them from cutting into the soft earth. The bowl of the scraper is made so that it may be raised or lowered, and is operated by lowering the edge of the scraper into the earth until the bowl is filled, after which it is raised a distance of some inches above the ground and carried to the dump or embankment, when the bowl is emptied by revolving it upon an axis from which it is hung. The cost of removing earth by wheel

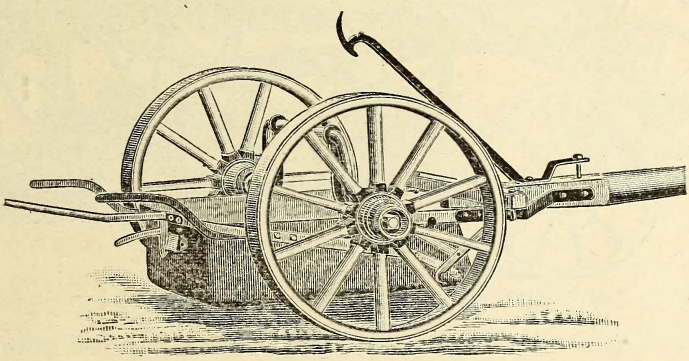


Fig. 33.—WHEEL SCRAPER IN POSITION FOR LOADING.

scrapers is somewhat less than that involved in the use of the drag scraper. * * * * * A wheel scraper of medium size will weigh about 450 pounds, will carry a little less than one-half a cubic yard, and will cost from $50 to $70. A drag scraper weighing about 100 pounds will cost from $12 to $15."

Mechanical Graders.—†"Within the last few years several machines have been devised for the purpose of handling earth more expeditiously and economically than can be done by hand; they are called by various names, such as 'road machines,' 'graders,' 'road hones,' etc. Their general form is shown in Figs. 34 and 35.

"Briefly described, they consist of a large blade made entirely of steel or of iron, or wood shod with steel, which is so arranged by mechanism attached to the frame from which it is suspended that it can be adjusted and fixed in any direction by the operator. In their action they combine the work of excavating and transporting the earth. They have been chiefly employed in the forming and maintenance of earth roads, but may be also advantageously used in preparing the subgrade surface of roads for the reception of broken stone or other improved covering.

†Byrne, page 580.

A large variety of such machines is on the market, and the price ranges from $100 to $300."

The accompanying illustration (Fig. 34) shows the "Champion" reversible road machine, manufactured by the American Road Machine

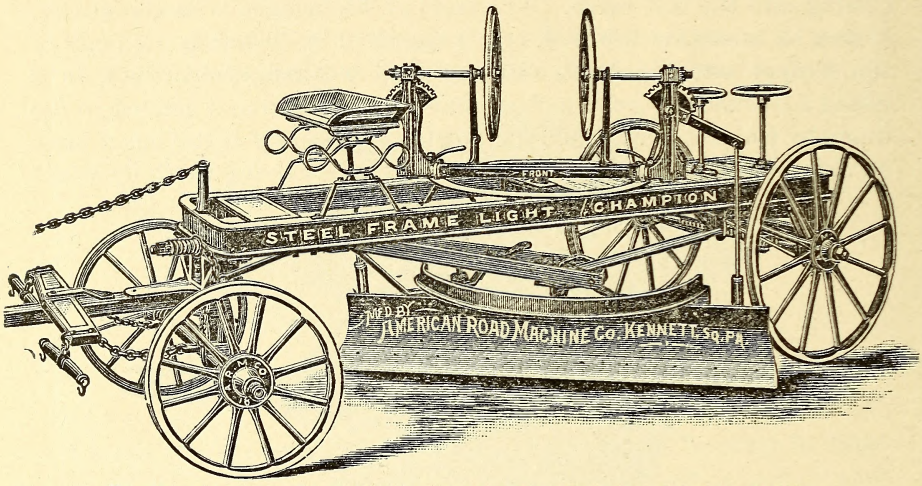


Fig. 34.—THE STEEL FRAME LIGHT CHAMPION REVERSIBLE ROAD MACHINE.

Company, Kennett Square, Pennsylvania, which can be had with either iron or wooden wheels—the latter being probably preferable. It can be easily pulled by four good mules and is said to be capable of doing as much work as 40 or 50 men, under favorable conditions. By tilting the blade it will cut the side ditches or gutters, as well as grade the road when the blade is properly adjusted. The price of it is $250.

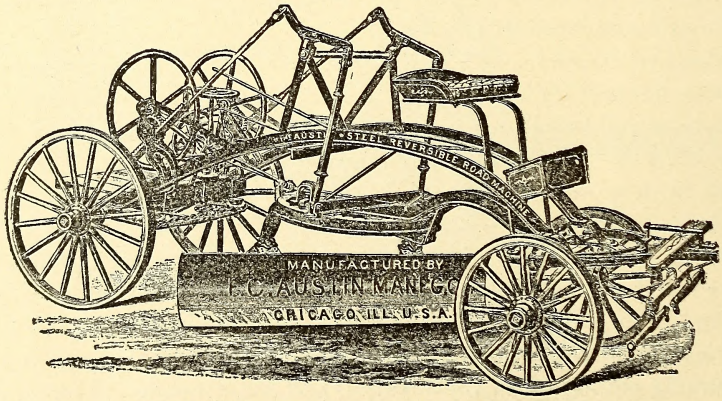


Fig. 35.—THE AUSTIN REVERSIBLE ROAD MACHINE.

Fig. 35 shows another form of road machine made by the F. C. Austin Manufacturing Company of Chicago.

"The New Era Grader," a machine recently introduced by the F. C. Austin Company, seems to be well adapted to the rapid handling of large quantities of earth at a comparatively low cost; and it promises to mark a considerable step in advance in the grading for railroads and wagon roads in comparatively level regions where the soils are fairly loose. But its adaptability for use on public roads in hilly regions and stony soils like those of midland and western North Carolina does not appear to have been demonstrated as yet. Persons desiring further information concerning the nature and work of this machine should correspond with the manufacturer in Chicago.*

Rolling.†—"Let us suppose that drains have been put in, culverts laid, banks sloped and the road surface given its proper shape. It is by no means a finished road even now, for in many parts the earth will be loosely compacted and in others scarcely settled at all. Rains will wash it, wagon wheels will sink into the surface and in a short time the earth will settle unevenly and take on a shape that will make you look upon it as a mortifying failure. You may obviate many if not all of these bad results by the thorough and proper use of a good roller. Every dirt road that is subjected to wagon traffic becomes hard by the process of rolling. Every wagon wheel acts as a roller, and when you consider the millions of wagons in use you may see the force of my statement when I tell you that if wagon tires were made of a width fairly proportioned to the heavy loads which they are required to sustain, our country roads would be vastly smoother and always in better condition than we find them today.

"You are familiar with the soft and cloggy condition of the ordinary country road in springtime, and know how the summer sun gradually evaporates the water and leaves the road surface roughened and cut by deep ruts and marred by occasional mud-holes where the deep water has not fully evaporated. To hasten the escape of the water I have advised thorough drainage, but to destroy ruts and preserve the road surface in good passable condition, rolling should be resorted to, and the more constant your rolling the smoother and more satisfactory will your road become.

"Great differences of opinion exist regarding the proper weight of roller to be used in the different kinds of road-making, but it is reasonably well settled that a roller of any given weight cannot be used to the same advantage on all kinds of roads, and that the weight of the roller in each case should, if possible, be adjusted to answer the condition presented. A comparatively light roller of large diameter may be used to advantage where the ground is soft and yielding, but the same

* For an illustrated description of this machine, see Byrne's Highway Construction, p. 580.
† *Good Roads*, Vol. II., No. 2, pp. 85, 86 and 90.

roller would hardly answer to consolidate heavy and moderately firm materials. It is therefore best, when possible, to use a roller which may be loaded and lightened at will to answer these several conditions, remembering, however, that the final work of the roller can hardly be done by too heavy a machine, and that the process of rolling is more likely to be discontinued too quickly than unduly prolonged, which latter is indeed hardly possible in ordinary conditions."

Horse Rollers.—Admitting the importance of using a roller in all road work, the question arises as to what kind of roller will be found most satisfactory for the work in hand. It is perhaps generally conceded that for work on city streets and on country roads where there are no weak bridges which might be broken down by the weight of

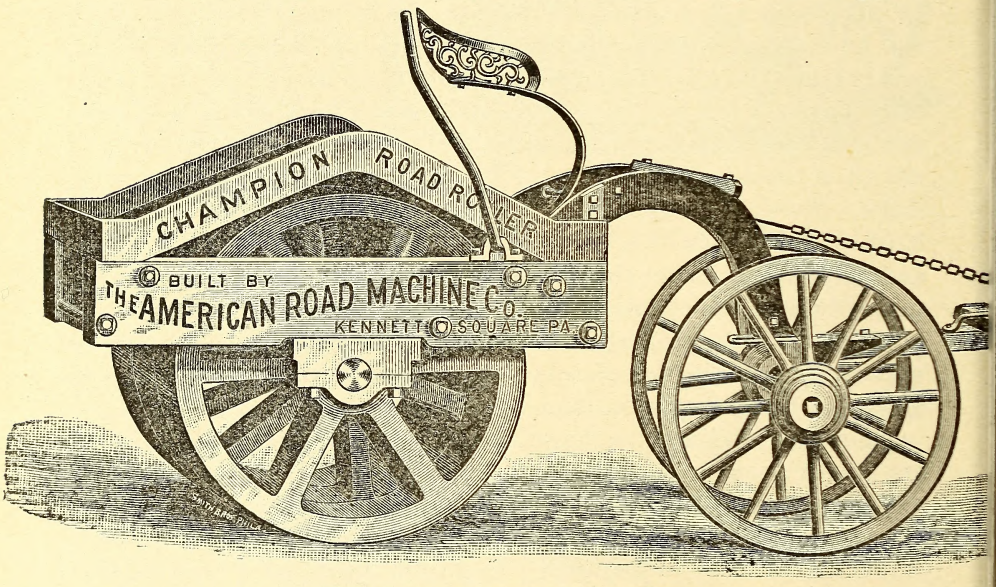


Fig. 36.—THE CHAMPION ROAD ROLLER.

the roller, and no especially steep grades to ascend, that the heavy steam rollers are preferable. But for the ordinary country road work a good horse roller answers the purpose fairly well and costs considerably less than the steam roller, though the expense of operating the latter is but little if any more than that of a large-sized horse roller. In the choice of a horse roller it is better to select one which does not bear heavily on the necks of the horses, and one the weight of which can be considerably increased by the use of bars of iron, masses of stone, or otherwise. In the Champion road roller shown in Fig. 36, the weight, which normally is three tons, can be quickly increased to five tons by the addition of two tons of railroad iron cut into 4-foot

pieces, or by adding masses of stone when the iron cannot be secured easily. The advantage of thus being able to increase the load will be apparent when it is understood that whereas over a rough and somewhat soft road surface it requires four strong mules to pull the 3-ton roller, after this roller has passed over the road several times and has begun to pack down the surface, the four mules can as easily pull the roller with its weight increased to five tons. And furthermore, it is often better for the road surface that when passing over it for the first few times the unweighted roller be used and that subsequently the weight be increased.

Other horse rollers are made by R. C. Pope, St. Louis; the F. C. Austin Manufacturing Company, Chicago, and the Gates Iron Works, Chicago.

Steam Rollers.—A steam roller may be described as a kind of locomotive mounted on broad heavy wheels, and used for compacting the road surface. They vary in weight from eight to thirty tons, the sizes

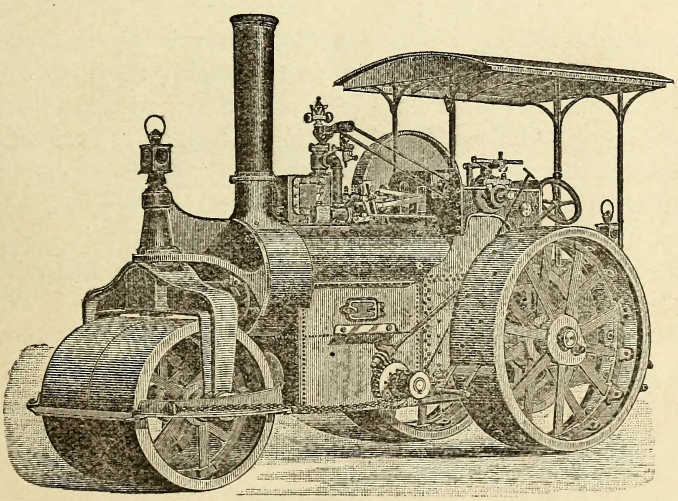


Fig. 37.—SPRINGFIELD STEAM ROAD ROLLER.

generally used weighing from eight to fifteen tons. The advantages of steam rollers are stated by Byrne as follows:*

"(1) They shorten the time of construction.

"(2) A saving of road metal, (*a*) because there are no loose stones to be kicked about and worn; (*b*) because there is no abrasion of the stones, only one surface of the stone being exposed to wear; (*c*) because a thinner coating of stone can be employed; (*d*) because no ruts can be formed in which water can lie to rot the stone.

"(3) Steam-rolled roads are easier to travel on account of their even surface and superior hardness, and have a better appearance.

*"Highway Construction," p. 183.

"(4) The roads can be repaired at any season of the year.

"(5) Saving both in materials and manual labor."

The Springfield steam roller manufactured by the O. S. Kelly Company, Springfield, Ohio (shown in Fig. 37), has been found quite satisfactory. The following information concerning this roller can be given best in tabulated form:

SPRINGFIELD ROLLER.

	10-TON.	12½ TON.	15-TON.
Front roll, diameter	4 feet.	4 feet.	4 feet.
Front roll, width	44 inches.	48 inches.	48 inches.
Driving wheels, diameter	6 feet.	6 feet.	6 feet.
Driving wheels, width	18 inches.	20 inches.	22½ inches.
Extreme width of machine	75 inches.	85 inches.	90 inches.
Pressure per inch of width	500 pounds.	570 pounds.	600 pounds.
Coal capacity	450 pounds.	500 pounds.	550 pounds.
Water capacity	153 gallons.	175 gallons.	200 gallons.
Maximum grade ascended with 100 lbs. stone	16 per cent.	16 per cent.	16 per cent.
Price	$3,500.	$4,000.	$4,500.

Other steam rollers on the American market are the Aveling and Porter roller, an English machine and probably the first of its kind on the market, now used largely in both England and America; and the Harrisburg patented double-engine roller, an American machine and used at many places in this country. Both these rollers are made in three sizes having different weights; the former 10, 15 and 20 tons and the latter 10, 12 and 15 tons in weight.

Tools for the Construction and Repair of Macadam Roads.—The following list gives the more important tools and machines which have been found useful in the construction and repair of Macadam roads:

Sledge hammers, 5 lbs. and over, for breaking masses of stone, per lb	$	$ .30
Hand hammers, 3 to 5 lbs., for breaking masses of stone, per lb.		.36
Hand hammers, 1½ to 2 lbs., for breaking masses of stone, per lb.		.45
Ring gauge, iron, 2 or 2½ in. in diameter for testing stone, each		.25
Tape lines, 100 feet long, in rolls	1.00 to	4.00
Straight-edge, wooden, made by any carpenter*		
Reel and stake, per dozen	6.00 to	9.50
Rakes, used for leveling stone, per dozen	14.00 to	16.00
Hand rammers, each	1.10 to	12.00
Levels, per dozen		48.00
Brooms, per dozen	8.50 to	9.00
Wheelbarrows, per dozen	20.00 to	52.50
Stone crusher, each	600.00 to	1,250 00
Rollers, horse, 2 to 5 tons, each	150.00 to	500.00
Rollers, steam, 10 to 15 tons, each	3,500.00 to	4,500.00
Drilling outfit, work by hand, each	100.00 to	150.00

*A good design is shown in Byrne's "Highway Construction," p. 590.

Drilling outfit, work by steam, each	$ 300.00 to $ 600.00
Derricks, for use in quarrying, each	50.00 to 200.00
Engine for running crusher, etc., each	650.00 to 800.00

Stone Crushers.—Breaking stone by hand for road purposes, which was formerly so extensively practiced, has now been generally abandoned—notwithstanding the claim that stone broken in this way is more uniform in size, has sharper edges and hence packs better—because, as is generally conceded, the steam crushers do the work much

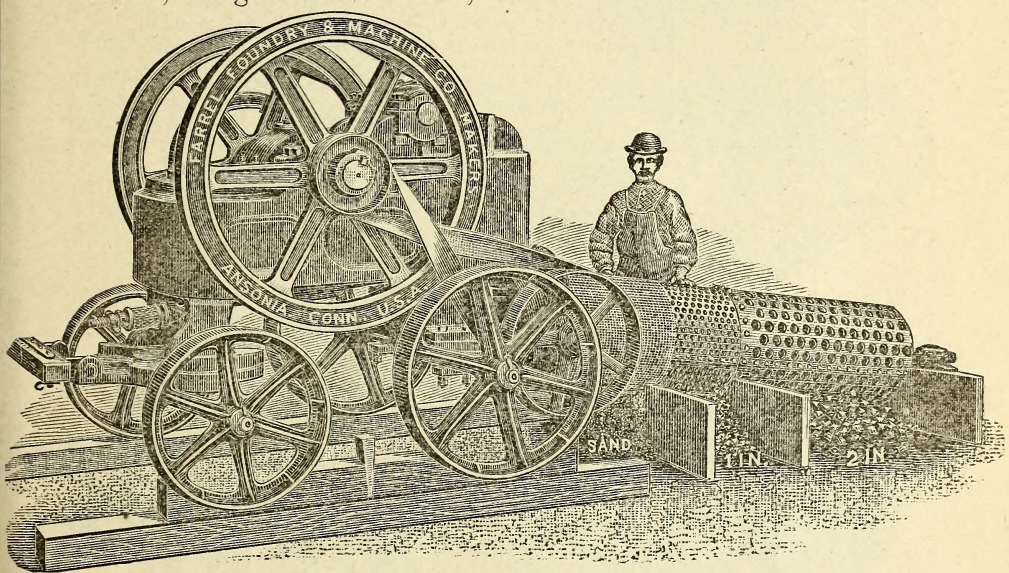


Fig. 38.—FARREL MARSDEN CRUSHER, MOUNTED ON WHEELS AND WITH SCREEN ATTACHMENT.

more rapidly and cheaply. At the present time a good stone crusher is regaredd as an essential part of an outfit for macadamizing roads. The following are among the leading crushers now on the American market:

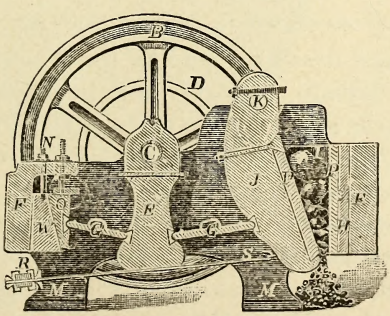


Fig. 39.—FARREL MARSDEN CRUSHER, SECTIONAL VIEW.

The Farrel Marsden crusher, manufactured by the Farrel Foundry and Machine Company, Ansonia, Conn., and by the Mecklenburg Iron

Works, Charlotte, N. C., is being used extensively. The accompanying illustration (Fig. 38) shows this crusher mounted on wheels, thus making it portable, and with attached screen for separating the different sizes of broken stone. When it is preferred not to separate these different sizes the screen can be removed. Fig. 39 shows a sectional view of the Farrel Marsden crusher.

FARREL MARSDEN CRUSHER: DIMENSIONS, CAPACITY, ETC. (*as published.*)

NO.	RECEIVING CAPACITY.	APPROXIMATE PRODUCT OF 2-INCH STONE PER HOUR.	APPROXIMATE WEIGHT.	HORSE P'WER	PRICE.*
3	10x4 inches.	3 cubic yards.	4,500 pounds.	6	$275.00
4	10x7 inches.	5 cubic yards.	7,600 pounds.	10	500.00
5	15x9 inches.	8 cubic yards	16,200 pounds.	20	750.00

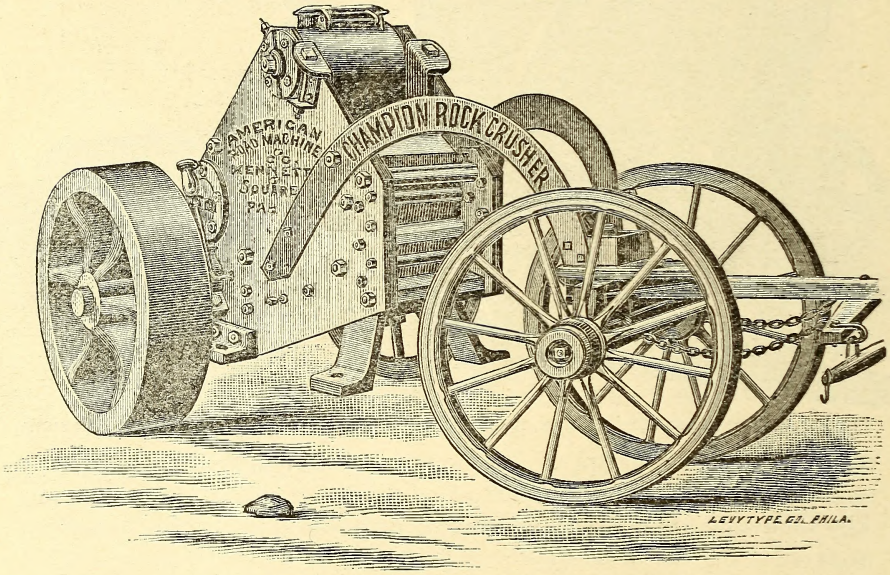


Fig. 40.—CHAMPION ROCK CRUSHER, PORTABLE VIEW.

The Champion rock crusher, made by the American Road Machine Company, Kennett Square, Pennsylvania, is shown in Fig. 40 in its portable form, and in Fig. 41 when stationary and at work with elevator and screen attachment. The front wheels and tongue shown in Fig. 40 when the crusher is stationary can be removed and used on the road roller shown in Fig. 36 (page 78). The elevator, 9 to 12 feet long, can be so arranged that the broken stone will fall directly into bins from which it can run into carts without being handled. The elevator and screen cost $400 additional to the price of the crusher.

* Price unmounted and without screen.

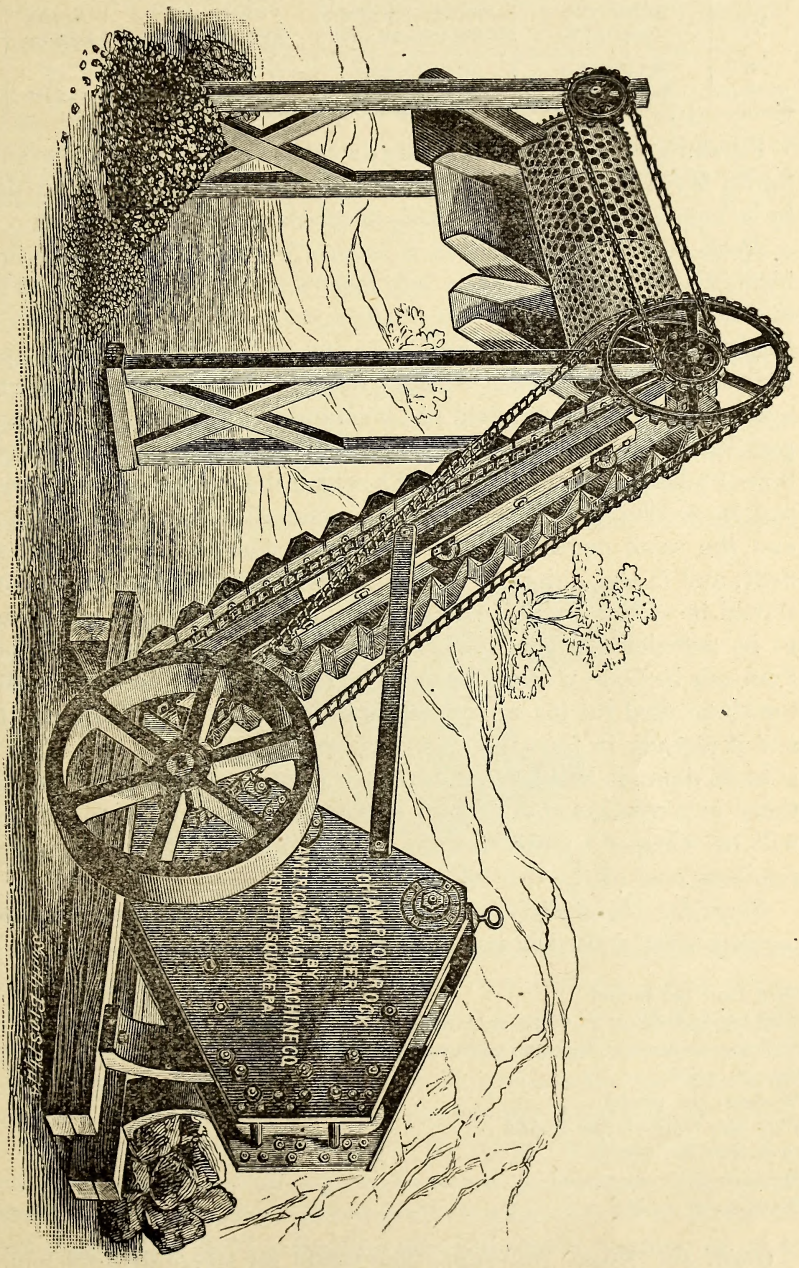


Fig. 41.—CHAMPION STEEL ROCK CRUSHER WITH ELEVATOR AND SCREEN ATTACHMENT.

CHAMPION CRUSHER: WEIGHT, CAPACITY, ETC. (*as published.*)

NO.	RECEIVING CAPACITY.	APPROX. PRODUCT STONE PER HR., 2 in	WEIGHT APPROXIMATE.	HORSE POWER.	PRICE.
3	7x13 inches	10 to 15 tons	5 000 pounds.	10	$600
4	9x15 inches	15 to 20 tons.	8,000 pounds.	12	800

Forster's crusher, the Brennan crusher, the Gates crusher and the Smith Hydraulic Safety crusher are also on the market and deserve to be considered in the purchase of stone crushing machinery.

Rock Drills.—The rock as it occurs in the quarry must first be blasted out and then broken into masses small enough—8 to 15 inches in diameter—to go into the crusher, where it is crushed into small fragments—2 inches and less in diameter—ready for distribution on the road surface. In the work of blasting out the rock at the quarry, until recently the hand-drill has been used exclusively, but during the past few years, where extensive operations are being carried on, it has been replaced by the steam drill, which does the work more rapidly and more cheaply. The crusher is generally located at the quarry, and the same engine which runs the crusher can also run the steam drill; and in the purchase of an engine for running the crusher one should be selected with several horse power more than what is claimed to be sufficient to run the crusher alone, so that extra work of this kind can be done without an extra engine becoming necessary. Where the stone used for macadamizing is picked up largely from the fields, and is already in fairly small masses and hence but little quarry work is to be done, it will be found cheaper to use the hand-drill; but where there is a considerable amount of regular quarry work to be done it will be cheaper to use the steam-drill notwithstanding the greater purchase cost of the drilling outfit.

Outfit for Hand Drilling.—The following list includes the more important articles used in hand drilling:*

Drill steel, per pound	$ .25
Striking-hammers, 3 to 5 pounds, per pound	.36
Striking-hammers, 5 pounds and over, per pound	.30
Spoons, each	2.00
Wedges, per pound	.12½
Plug and feathers, per pound	.30
Crowbars, per pound	.10
Stone-sledges, per pound	.30
Blacksmith outfit	50.00 or more.

Outfit for Steam Drilling.—The outfit for steam drilling includes† a steam drill, a set of drill-steels; a set of blacksmith's tools for sharp-

* Byrne, "Highway Construction," p. 586. † *Ibid*, pp. 587-'9.

ening the drills; a sand pump; a band for centering the piston; extra drill parts; and a steam hose. The following table shows the approximate prices of such an outfit:

Drill and tripod complete	$ 175.00 to $350.00
Steam hose, per foot	.54 to .97
Drill steels, per set	25.00 to 115.00
Forge and hand tools	50.00 and upw'd
Sand pumps, each	$ 3.00
Giant blasting powder, per pound	.15 to .60
Leading wires, per foot	.01 and upw'd
Magneto-electric blasting apparatus, each	25.00 to 50.00
Derricks, each	50.00 and upw'd

These drills and outfits are manufactured and for sale by the Rand Drill Company, New York, and by several other companies.

Engines or Boilers.—Almost any good portable engine and boiler of sufficient power will answer for running the rock crusher, rock drill, dump cars, etc. It is better in purchasing to select one which can give a greater power than is called for in advertising statements;

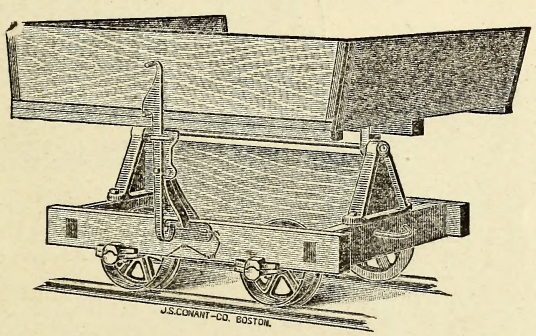
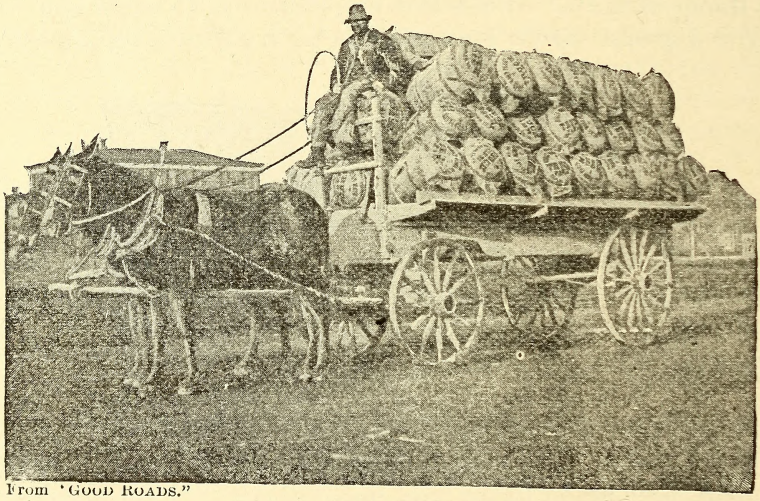


Fig. 42.—STEELE'S DUMP CAR.

for if it requires to run a rock crusher a 10-horse power it is safer and more economical to get this force from a 12-horse power boiler than from a 10-horse power boiler. And where the rock crusher and steam drill and dump-cars are to be operated at the same point (at the quarry) it is better to get an 18- to 20-horse power engine, as the cost does not increase in the same ratio as the horse power. Thus of the Ajax engine, which is claimed to be one of the best now on the market, the 12-horse power engine, mounted on wheels, costs about $665 and the 18-horse power about $780—a gain of 6-horse power at an additional cost of $115. Engines adapted to the running of rock crushers are manufactured by the Mecklenburg Iron Works, Charlotte, North Carolina, and by other establishments.

Dump Car and Winding Drum.—It has been found that the dump cars (Fig. 42) and winding drum manufactured by J. C. Steele of Statesville, N. C., for use in hauling clay from the pit to the mills are also well adapted to hauling fragments of rock from the quarry to the crusher, and it is claimed that in this latter capacity they can be used on the automatic switch, also manufactured by Mr. Steele, to a considerable advantage, being operated by the same engine as that which runs the crusher, or crusher and steam drill, and thus saving the employment of several men and carts to do this work.

Draining Tools.—In ditching for drainage where it is intended to use tile, as advised above (p. 48), and in laying the tile, special forms of spades and other tools have been found useful and inexpensive. These can be obtained from any large dealer in road machinery. They are fully illustrated and described in Byrne's *Highway Construction* (pp. 585–6), and in *Good Roads*, for July, 1892 (p. 33).



From "Good Roads."

Fig. 43.—THE RESULT OF INTELLIGENT WORK IN KEEPING A DIRT ROAD. SIXTY BARRELS OF GARDEN TRUCK HAULED BY A SINGLE TEAM ON DIRT ROAD AT CAPE CHARLES, VA.

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CORRECTIONS AND ADDITIONS.

On page 51, twelfth line from the bottom, after the word "firm" insert "as."

On pages 59 and 60, plates for Figs. 23 and 24 have been kindly supplied by the O. S. Kelly Company.

On page 62, tenth line from the top, for $176 read $282; in the ninth line from the bottom for $60 read $94, and for $120 read $188; in the footnote, for 5,867 read 9,387.

On page 64, second line from the top, for $900 read $1,400, and for $1,500 read $2,300.

On page 65, tenth line from the bottom, for "yearly" read "daily."

On page 67, in the bottom line, between the words is and of insert $\frac{1}{10}$.

NORTH CAROLINA GEOLOGICAL SURVEY.

J. A. HOLMES, STATE GEOLOGIST.

BULLETIN No. 5.

THE FORESTS, FOREST LANDS, AND FOREST PRODUCTS OF EASTERN NORTH CAROLINA.

BY

W. W. ASHE,

In Charge of Forest Investigation.



RALEIGH:
Josephus Daniels, State Printer and Binder.
PRESSES OF E. M. UZZELL.
1894.

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., September 26, 1894.

To his Excellency, HON. ELIAS CARR,
Governor of North Carolina.

SIR:—I have the honor to submit herewith for publication as Bulletin No. 5 of the Geological Survey publications a preliminary report on the Forests, Forest Lands and Forest Products of Eastern North Carolina. This report has been prepared by Mr. W. W. Ashe, who is making for the Survey a careful examination of the forests of the State. I beg to call your special attention to two facts brought out in this report: (1) the continued and unnecessary destruction of the forests of our eastern counties by fires and stock, and the importance of remedying this evil before it is too late; (2) while we cannot at once greatly enlarge the areas of our turpentine orchards the quality and value of the naval store products may be increased to the extent of some $200,000 per annum by the adoption of the French system of gathering the turpentine.

I desire to express my appreciation of the active and encouraging interest which you and the other members of the Board have shown continuously in this and all other work undertaken by the Survey.

Yours obediently,

J. A. HOLMES,
State Geologist.

PREFACE.

The law inaugurating the Geological Survey provides for the investigation of the timber as well as the mineral interests of the State; and in carrying out this provision a systematic examination of the forests was begun in 1891 and has been carried on since that time. The plan adopted in this work embodies a fourfold investigation: first, as to the existing forest resources; second, as to how these resources can be utilized to the greatest advantage without involving the destruction of the forests; third, as to how the waste lands of the State can be continuously restocked with valuable trees, and thus our forest wealth perpetuated; and fourth, as to what can be done to encourage the development in the State of enterprises which will manufacture into finished products a larger portion of our timber instead of shipping to other States our crude materials for manufacture there. We have found, as will be shown in this Report and others which are to follow at an early date, that our forest resources are considerable; and they are now attracting lumbermen and capital from many sections of the country. The lumbering industry in the State is already a large one and is increasing in magnitude; indeed, already the timber is being cut with such rapidity that we may fairly ask ourselves the question, how long it will be before our forest wealth, like that of many other States, becomes a matter of the past. And we may also ask ourselves the question, whether it is possible that these resources can be utilized now and at the same time our forest wealth be perpetuated.

A trained student in forestry will answer this latter question in the affirmative, but the experience of the past has too often answered it in the negative. The cutting of the valuable timber frequently leads to the total destruction of the forest. The trees are felled regardless of surrounding growth that may be injured; and the branches and the tops are left scattered among the younger growth and thus add greatly to the destructiveness of forest fires, which frequently follow during the first dry season. The

average lumberman has but one purpose in the prosecution of his work: the removal of the valuable timber. It rarely happens that the owner, himself, seriously considers the future welfare of his forests; and, indeed, the opinion seems to be prevalent in the public mind that when the valuable timber has been once removed from a forest the forest itself no longer has a value, and may as well be cleared away so that the soil can be cultivated; or, if it is allowed to remain, it is usually made to serve as a range for cattle, and is thought to answer this purpose best when burned through by the forest fires every autumn or spring.

The policy of the average citizen appears to be based upon the theory that our natural resources are inexhaustible, and that we should get all out of them we can to-day and let the future take care of itself. And so thoroughly grounded are these notions in our public and private policy that it is exceedingly difficult to secure the adoption of any plan which runs counter to them. But fortunately, in the matter of our forests, their preservation for use by a future generation need not prohibit the utilization of the valuable timber now standing by the present generation. It only demands that while we cut and make use of this timber we protect the young growth, and look to the restocking of our waste lands with valuable trees, and thus make the forest valuable for future generations also.

The examinations of the forests in Eastern North Carolina were begun by the present writer several years ago. More extended investigations have been carried on by Mr. W. W. Ashe at intervals during the past two years. The larger part of the information embodied in the present report was collected by him during a series of extended trips made through the eastern counties during the autumn of 1893 and the following winter. As shown in the body of this Report, the approximate supply of pine timber now standing in Eastern North Carolina is about 8,200,000,000 feet, and this is being cut at the rate of about 450,000,000 feet per annum. These figures point in unmistakable terms to the fact that, unless meanwhile we encourage the growth of new trees, two decades more will find the valuable pine forests of this region largely a thing of the past. And it is unfortunately true that the cutting of this timber is often followed by the destruction of the forest.

Indeed, nothing in the way of forest management could be more reckless and destructive than the treatment of our long-leaf pine forests during the past few decades. In the boxing for turpentine the trees have been cut so deeply and so extensively that both their vitality and strength have been greatly weakened, and the storms have prostrated many of the finest specimens. The lumberman and the storms have been followed by forest fires, which have completed the destruction, already begun in so systematic a manner, of large areas.

Started at times by thoughtless hunters at night, by sparks from an engine, by careless squatters or tenants, or even at times by land owners, in the hope of improving the grazing capacity of their lands during the following season, these forest fires sweep irresistibly across miles of territory, destroying not only the mature forest trees, but also the young growth; and thus destroy the forest of the future as well as of the present. And the few young pines which may have escaped destruction in this way soon follow the fate of the others by being destroyed by hogs. Many of these long-leaf pine lands which lie in the sand hill regions of Eastern North Carolina have had their forest removed so completely that they have become "waste lands," covered by a thin growth of nearly worthless scrubby oak. The total area of these waste lands is now nearly half a million acres, and is steadily increasing. This Report endeavors to show that while much of these waste lands are worthless for other purposes, they can be re-set with long-leaf pine forests if they can only be protected against forest fires and stock. And it is gratifying to find among the lumbermen themselves a growing realization of the fact that it is to their interest and to the interest of the public at large that this destructive policy give place to a more intelligent plan which, while it does not seriously curtail the utilization of the existing forests, it looks to their protection and perpetuity.

It is devoutly to be hoped that this awakening will grow into a change of both public and private opinion concerning the future of our forests, and lead to the adoption and carrying out of rational plans for their perpetuity and improvement. The problems connected with the accomplishment of this end will be discussed

more fully in future publications of the Survey, now in preparation. The object of the present report is to describe briefly the present condition of the forests and forest lands of this region. The capital invested in the lumber industry in Eastern North Carolina in 1893 amounted to $4,690,000, and more than 8,000 men were regularly employed in connection with the 323 establishments. The market value of the forests products of this region for 1893, including naval stores, but not including fire-wood nor fencing material, amounted to $7,320,000. Including these latter items the aggregate annual value of the forest products of the region will probably reach $12,000,000. Certainly this is an industry the future maintenance of which deserves the earnest consideration of the State and her individual citizens.

The Survey is indebted to many lumbermen, naval store dealers and manufacturers, and to many other citizens in every part of this region for their kind co-operation in the work of collecting information for this Report, and I beg to assure them that their kindness and hospitality have been highly appreciated.

J. A. Holmes,
State Geologist.

North Carolina State Library.

FORESTS, FOREST LANDS AND FOREST PRODUCTS OF EASTERN NORTH CAROLINA.

By W. W. Ashe.

CHAPTER I.

FORESTS AND FOREST LANDS.

OBJECTS OF THIS PRELIMINARY FOREST SURVEY.

During the present decade there has been a marked increase in the lumber industry in Eastern North Carolina and a corresponding decrease in the available supply of standing timber. Already predictions are numerous as to the exhaustion at an early date of the supply of merchantable long-leaf pine over considerable areas. The boxing of these pines weakens the trees and makes them more liable to be blown down by the winds, and far more liable to be destroyed by forest fires, which by their frequency and extent have entirely removed the long-leaf pine forests over many large areas. These pine forests, in the sandy regions, instead of being replaced by a valuable young growth of the same kind are followed by a worthless growth of sand black-jack oak. Forest fires and subsequent pasturing of these regions with cattle and hogs are the important agencies which combine to prevent the long-leaf pine from reproducing itself over the larger portion of these sandy lands. From these causes the extent of these areas of waste or abandoned lands is increasing steadily. It is believed that under proper management these waste lands can be restocked with long-leaf pine.

The present examination was undertaken with a view to determining the exact condition of the forests of the eastern section of the State, the rapidity with which they are being removed, the condition of lumbered districts, the character, extent and condition of the regrowth or "second growth," and to find out, if possible, some practicable plans for the protection, development, and extension of the forests of this region.

AREA UNDER CONSIDERATION.

The area examined embraces thirty-eight eastern counties and the eastern parts of six more, being what is usually termed the long-leaf pine belt in North Carolina. This is the "coastal plain region" of the geologists, which extends inland from the coast a distance of one hundred to one hundred and fifty miles and has in this State an aggregate area approximating 24,000 square miles. Its western border, separating the hill country from the coastal plain region, may be described as an irregular line extending through the western part of Halifax and the south-eastern part of Franklin county, passing near Raleigh and Cary to northern Montgomery and eastern Anson counties. Its surface is that of a gently undulating plain, of less elevation (ten to twenty feet above tide) and of a more nearly level surface eastward, becoming more elevated (three hundred to five hundred feet) and rolling along its western border. Its soil is generally a sandy loam or sand, though in limited areas clay predominates. In the more eastern portion of this region are numerous extensive swamps or marsh areas surrounding, in some cases, small lakes and bordering streams. In some of these the soil is mainly an admixture of sand and vegetable *mold*, while in others it is a fertile loam. The soil of the western portions of this region, north of the Neuse river, varies considerably, but is ordinarily a loam, becoming sandy or gravelly in some places and clayey in others, while south of Neuse river the sand predominates, and there are numerous elevated, dry, sandy ridges on which only the long-leaf pine and the sand black-jack oak flourish.

KINDS OF GROWTH.

The timber over the entire section is, on the highlands, largely of two species of pine, one, the loblolly pine (*Pinus Taeda* L.), more confined to the counties north of the Neuse river and to the moister soil; the other, the long-leaf pine (*Pinus palustris* Mill.), to those south of this river and to the drier, more sandy soil. Beneath these trees, where the soil is not too dry and sandy, is a lower

growth of small white and post oaks, dogwood, haws and the narrow-leaved crab-apple, while where the soil is very sandy and dry there grows, either with the long-leaf pine, or where it has been removed, a small worthless oak, the sand black-jack or barren oak (*Quercus Catesbaei* Michx.), and less frequently the high-ground willow oak (*Quercus cinerea* Michx.). This oak is also a small tree and indicates the most barren soil. Besides the pines just referred to, there are two others found with them, the short-leaf pine (*P. echinata* Mill.), an uncommon tree except on dark loam or gravelly soil along the western and northern limits of this section, and the savanna pine (*P. serotina* Michx.), a knotty, unsymmetrical tree occurring from Virginia southward along the margins of "pine barren" ponds or scattered in small clumps over the open savannas and marsh lands. These few species form the chief growth of the higher lands.

The swamp lands, with a total area of about 3,500 square miles, have a very characteristic and varied growth. Bordering these swamps are water and willow oaks, with the evergreen loblolly bay and sweet bay; farther in them are huge swamp chestnut oaks (*Quercus Michauxii* Nutt.), elms, maples, beech, holly and tall rosemary pines (*P. Taeda L.*). These lands constitute the *oak flats*, areas which are under water only during the wettest seasons of the year. They have usually a good soil and can be easily drained.

Where the water is deeper in the swamps and remains longer grow the cypress, sweet gum, black gum, tupelo and yellow poplar.

In the mud swamps along the larger streams there are, besides cypress and gums, ash, overcup oak, cottonwood, sycamore and hackberry. Mixed with the other swamps, but covering less area and occurring only on sandy or peaty soil, are white cedar swamps, or "juniper bays," as they are usually called. The tree growth in these is largely and often entirely juniper or white cedar (*Chamaecyparis spheroidea* Spach.) and white bay (*Magnolia glauca* L.). In the extreme eastern part of this section, in the immediate vicinity of the sea-coast, there is a characteristic arborescent flora of red cedars and live oaks, while along its southern limits the palmetto and American olive (*Olea americana* L.) give it a semi-tropical aspect. On the other hand, as the clay and loam of the

hill country is neared, the oaks and hickories rapidly increase among the pines, making the transition to the hardwood uplands.

While this does not exhaust the list, even of the useful trees of this section, it includes those of greatest importance and widest distribution, and those most characteristic of the region. Those, however, which at present are of greatest economic importance are the pines, cypress, white cedar, ash and yellow poplar, and these only will be considered in detail, as the other forest trees of this section are not yet subject to the destructive agencies which prevent the extensive propagation and even threaten the future existence of at least one of the most valued of these trees.

NOMENCLATURE OF THE FOREST TREES.

The names of many trees occurring in the State are very much confused, some trees having several names applied to them in the same locality, while in other localities the same name is given to several distinct species. This is particularly true of the pines of the eastern section, so much so that they frequently cannot be distinguished at all by their local names. Names which are in very general use, and the use of which will prevent confusion, are those adopted by the United States Forestry Bureau. These names will be used throughout this report and are given in the following table along with the corresponding botanical terms and a list of the other names generally used in this State, with the region to which they are peculiar:

Long-leaf pine (*Pinus palustris* Mill., *P. australis* Michx.) is known everywhere by this name, but *long-straw pine* is a term frequently substituted for it, the leaves of the pine after they have fallen being always called "straw." *Long-leaf old-field pine* is the name given to the young growth in fields, etc. *Pitch pine* is used in the north-eastern counties and by turpentine distillers. *Heart pine, North Carolina pine, Georgia pine* and *yellow pine* are lumbermen's names.

Loblolly pine (*P. Taeda* L.) is a name rarely heard in this State in the field, *short-leaf* or *short-straw pine* being the usual name. *Long-straw pine* is heard in the north-east, where this tree grows

with *P. echinata* (the short-leaf pine), and *rosemary pine* is used along the Cape Fear river. *Slash pine, swamp pine* and *old-field pine* are names frequently given to it. *Sap pine, North Carolina pine* and *North Carolina sap pine* are names in use among lumbermen.

Short-leaf pine (*P. echinata* Mill.).—*Short-leaf pine* and *yellow pine* are names given it in the middle and western sections of the State, and it is there also the *old-field pine.* It is *spruce pine* in eastern and south-eastern counties and is known among mill men as *North Carolina* and *yellow pine.*

Savanna pine (*P. serotina* Michx.) is also called *short-leaf,* and other names for it are *old-field pine, bastard short-leaf, swamp* and *pocosin pine.* This pine is seldom recognized as distinct from the loblolly. Its most frequent designation where so distinguished is *pocosin pine,* from its growing in flat, marshy land; the flat, undrained lands, usually at the heads of streams, being called "pocosins." These pocosins are covered with a low growth of gums, this pine, and an undergrowth of gallberry bushes, huckleberries and andromedas, while in places there is more or less coarse, densely stooled grass and sedges. This land often appears to be on the point of becoming savanna land, should the drainage become more thorough or its surface be raised by an accumulating peat. The common names for the other trees of this region, which are being discussed as being at present of considerable economic importance, are widely known and merely deserve mention: *Cypress* (*Taxodium distichum* Rich.); *yellow poplar* (*Liriodendron tulipifera* L.); *white cedar* (*Chamaecyparis spheroidea* Spach.), often called *juniper,* a name that is also applied to a small shrub farther north. Although three species of *ash* occur no distinction is made between them, each being called simply ash. These three species are the *water ash* (*Fraxinus platycarpa* Michx.), *white ash* (*F. Americana* L.) and *red ash* (*F. pubescens* Lam.). The first of these is a small tree confined in this State to swamps in the extreme eastern and southern parts. The other two are larger trees and occur in all parts of the State, either in swamps, along streams or in moist, cool places.

ORIGINAL DISTRIBUTION OF THE PINES.

The distribution of the pines and the respective area occupied by each in this State has changed a great deal since the first exploration of the country.

LONG-LEAF PINE (*P. palustris* Mill.).—The distribution of no tree has been more affected than that of the *long-leaf pine* by the transformation from a wilderness to a civilized country. The long-leaf pine formerly extended over the entire area under consideration, growing upon the drier portion of the sand. In the southern and south-eastern counties it formed a forest of pine, unmixed with other trees, but in the northern and western counties it was confined to the sandy or gravelly drift along the higher and drier ridges, here intermixed with short-leaf pine and scattering oaks, while poplar and loblolly pine occupied the lowlands.

Early in the last century the production of tar and turpentine was a profitable industry north of Albemarle sound, the commodities being taken to Norfolk or Nansemond, Va., for market.* The crude turpentine was shipped to England and there distilled. The largest bodies of pine which then yielded turpentine were the one on "Sandy Ridge," lying to the north of Edenton, and another east of Chowan river, in Gates county, and extending north into Nansemond county, Va. Before 1850 these had ceased to be of economic consideration, such trees as had withstood the fires and wind having been converted largely into building material. Now only isolated trees are to be seen here, scattered among black-jacks on the highest land. That they ever occupied much of the land might be questioned but for the tar-kiln mounds with which these counties are studded, the land having now a heavy growth of loblolly pine, and the mounds even bearing trees of this latter species two or three feet in diameter.

Southward these pines occurred only scattered over the high, sandy land lying between Albemarle sound and Washington. Now a tree of this species is rarely seen here. Between Washington and Newbern on a high sand ridge, with an area of 35,000 acres, was the finest body of pine in the Pamlico peninsula, but there is

*Wm. Byrd, Westover MS., Petersburg, Va., 1841, p. 27. (This manuscript was written in 1729).

now very little merchantable timber of this kind left on it. West of this body it occurred in Beaufort, Craven and Pitt counties, only thinly dispersed among the loblolly pines as far as Kinston in Lenoir county, where on a suitable soil it again became the dominant forest tree, extending west as far as Enfield, and nearly to Raleigh. On the maritime sand hills just within the sounds there was a narrow belt in Currituck county, and in Carteret a wider belt in the middle of the county, lying north and south, parallel to the coast. In Currituck it is now confined to the southern promontory which projects into Albemarle sound, and in Carteret there are only several million feet of mill timber on the sand ridges opposite Bogue sound. From Carteret southward there was some uniformity as to its manner of occurrence. It occupied a belt from two to twenty miles wide immediately on the coast; beyond that lay a poorly drained basin of variable width and broken contiguity, embracing oak flats and gum and cypress swamps. The long-leaf pine re-appeared west of this and extended in an unmixed forest, broken only by river swamp, streams and occasional "juniper bays," to its western limits at Cary to ten miles west of Troy, and to Lilesville in Anson county. It is in this stretch of country that the largest areas lie which are either partially or completely denuded of all valuable tree growth and where a future growth is being entirely kept down by the systematic burnings to which those lands are subjected.

South of North Carolina the long-leaf pine extends through Eastern South Carolina and Georgia, Southern Alabama and Mississippi, and west of the Mississippi river it re-appears in the sandy uplands of the valleys of the Red and Sabine rivers in Louisiana and eastern Texas, where it reaches its greatest development.

The quality of the wood of this pine varies considerably with the character of the soil on which it grows. Where the humus covering on the soil is thin, and the sand very deep, the tree has a coarser grain and a larger proportion of sap than where there is more organic matter in the soil, and it is not so highly silicious. The stocks with the coarser grain and larger amount of sap wood are distinguished as *pitch pine,* those with the finer grain and less sap wood as *heart* or *yellow pine.* The *pitch pine* yields turpentine

more abundantly, can be worked for a longer time, and is less injured by repeated boxing and chipping. It is the more abundant in Onslow and Brunswick counties near the sea-coast, and on the highest sand hills of northern Bladen, Sampson and Cumberland counties. The *yellow pine*, containing mostly heart wood, makes the finer lumber and is the variety sought for by lumbermen.

Loblolly pine (*P. Taeda* L.) was originally confined to the lower and moister land, especially where it was loamy or slightly clayey, over the entire coastal plain region and westward beyond it about forty miles. While its limits have not materially changed it has increased its acreage, occupying now some of the higher and more sandy land, especially tracts which have once been under cultivation and much of the moister soil once completely or partially occupied by the long-leaf pine. Some original loblolly land which had a clayey or gravelly soil has been occupied by a heterogeneous growth of oaks, the white, post and black oaks and the black-jack being those that form the greater portion of the hardwood growth. As in the case of the long-leaf pine, the quality of the wood of the loblolly pine varies considerably with the different kinds of soil upon which it grows, and these variations in the wood and habit of the tree have given rise to the use of different local names which are applied by many persons throughout this region to what are considered by them different varieties of the "short-leaf pine," as the loblolly is commonly called. They are all, however, the same species (the loblolly pine) and their differences in quality of wood and appearance are due simply to dissimilarity of soil and other conditions which surround their growth. The principal kinds to which local names have been given are the following:

(1). The *rosemary pine* has a fine-grained (or sometimes coarse) wood, with a thin sap. It grows along the borders of deep swamps, or on mounds and hummocks within them, which are usually flooded during winter and spring. It grows with gums, cypress and ash, and is here the largest of the native pines, frequently attaining a diameter of 5 feet and a height of 130 to 140 feet, with a clear trunk of 80 to 90 feet. It has a bright brown bark broken into large, smooth, rectangular plates. It is found from

Virginia southward, the best developed trees recently observed being found on the Cape Fear river and its tributaries. South of the Cape Fear river they are not common. Some of these trees show on being cut that they are over 400 years old.

(2). The *swamp* or *slash pine*, which is the most frequent form of the loblolly, has a coarse grain, with the sap wood occupying half or even more of the diameter. The tree is smaller and the wood not so highly valued as that of the preceding, and is also said to decay more rapidly. It is most common on the moist or wet lands north of the Neuse river, where it forms a compact forest; and through this region and in the adjacent parts of Virginia it is the chief lumber tree.

(3). The *old-field pine* is a growth of the loblolly pine which is often looked upon in the south-eastern counties as a tree distinct from each of the preceding. It is, however, only a vigorous, exceedingly coarse-grained loblolly pine, which, having grown very fast, has only a small proportion of heart, logs 2 to 2½ feet in diameter rarely having one-fourth of their diameter heart. Of this open-grained wood both heart and sap decay rapidly on exposure to the weather unless painted or otherwise protected. But it is now being used very largely for indoor work, for which it is well adapted.

Short–leaf pine (*Pinus echinata* Mill.) is found mixed with hardwoods on all the dark, gravelly loam of the uplands and is there the chief lumber pine. In the eastern counties it was originally only scatteringly distributed, even in those adjacent to Albemarle and Pamlico sounds, where it was most abundant. From here it has been largely removed. South of Neuse river it was a rare tree, being found in small clumps interspersed among the long-leaf pines where the soil was inclined to be a dry or gravelly loam. Some trees on fertile soils become very large and have been removed for "tun timber." The wood of these larger trees is only a little coarser than that of the long-leaf pine; it is much lighter, though, and more brittle. On the sandy soil of the coastal plain region it does not abundantly reproduce itself, and young trees are uncommon, but on the uplands it is rapidly increasing and its young growth promises to play an extensive part in the future

development of this section. As it has the smallest cone and shortest leaf of any pine in the eastern portion of the State it can be readily distinguished. This pine has a wide distribution, extending north to Massachusetts and west to Kansas and eastern Texas. It always occurs mixed with hardwoods or other pines.

Savanna pine cannot readily be distinguished from the loblolly in young trees, but mature trees are easily separated. It is a medium-sized tree, whose trunk holds its size well, being covered with limbs and knots for the upper two-thirds of its height. The leaves are similar to those of the loblolly, but the bark is a darker brown and smoother. It is always covered with cones, which remain on for several seasons. These are shorter than the cones of the loblolly, conical, and usually have the scales closely oppressed. This species is of but little commercial value and is rarely used for the reason that the wood is coarse-grained and gummy, with a large proportion of sap wood, and the trees are frequently unsound. The savanna pine has been but slightly affected by the causes which have operated to increase or diminish the distribution of the other pines. Being sawn for lumber only by accident, and growing only on a few kinds of soil, and such soils as are unfit for agricultural purposes, the amount of it standing to-day is practically the same as formerly.

FORESTS AND FOREST REGIONS IN EASTERN NORTH CAROLINA.

The following descriptions of the counties of the coastal plain region show, in a general way, not only the quantity of merchantable timber now standing in the several counties, but also, when such figures were obtainable, the areas and character of such lands as have been lumbered. They also show the condition in which these lands were left after being cut over, and the kind of young growth which is succeeding the one removed, whether it be the same or a different kind, and give such tracts as have been burnt over after lumbering, on which the tender young growth and trees which might serve for seed trees have been partially or completely destroyed.

The acreage of the various kinds of timber, excepting the long-

leaf pine, is prepared from information furnished by county officials, lumbermen and residents familiar with the lands of their respective sections. The amount of standing long-leaf pine is an estimate based on the number of barrels of rosin produced in each county, the unboxed round pine and the abandoned orchard also being taken into consideration. These figures were corrected in some instances by the estimates obtained direct from the acreage of standing pine, the figures for such acreage coming from county records which show the character of the timbered lands of the townships. Besides this a thorough personal examination was made of the condition of the timbered lands in different sections of each county.

The counties, beginning with those that lie nearest to the coast and proceeding inland, have been grouped according to the character of their dominant economic timbers as they stand at the present time.

THE SEABOARD REGION lies along the coast or but a short distance inland. It has an elevation of from 10 to 100 feet above the sea-level. Its average altitude, however, is not over 30 feet, and the only points which attain an elevation above 70 feet are a line of drifting sand dunes along the north-east coast, which in places are over 100 feet high.* The counties included in this region are Columbus, Brunswick, Pender, Onslow, Duplin, Carteret, Jones, Craven, Pamlico, Beaufort, Hyde, Dare, Tyrrell, Washington, Chowan, Perquimans, Pasquotank, Camden and Currituck. These counties have loblolly pine as the dominant forest tree, though in the most southern ones there is considerable long-leaf pine, and there are numerous swamps with a growth of sweet and black gums, cypress and white cedar.

THE INLAND LOBLOLLY PINE REGION, which lies along the Neuse river and north of it, farther inland than the seaboard, embraces the counties of Gates, Hertford, Bertie, Martin, Pitt, Greene, Edgecombe, Wilson, Lenoir, Wayne and Johnston. Their elevation is slightly higher than that of the seaboard counties, and will average between 100 and 150 feet, being higher toward their western borders. Their upland growth is nearly all loblolly pine, except

*Geology of North Carolina, W. C. Kerr, Vol. I, 1875, pp. 13-19.

that in Lenoir, Wayne and Johnston counties there is considerable long-leaf pine. There are few swamps except along the streams.

The pine-barren regions.—The counties containing the larger portion of the pine-barren areas are New Hanover, Sampson, Bladen, Robeson, Cumberland, Harnett, Richmond and Moore. These lie south of the Neuse river and just west of the southern seaboard, excepting New Hanover, which is situated at the mouth of the Cape Fear river. The altitude of these counties varies between about the same limits which were given for the inland loblolly pine counties. Long-leaf pine or the sand black-jack, which has largely replaced it, is the characteristic growth of these counties.

The transition region.—Nash, Halifax and Northampton counties form a tier of counties which are transitional between the loblolly uplands and the hardwood hills. These in their western portions have an altitude of from 200 to 400 feet, while their eastern portions lie at a lower level. They have no swamps except narrow strips of alluvium lowlands along the streams, which are subject to overflow. Montgomery, Chatham and Wake form another tier of transitional counties. They lie partly in the long-leaf pine belt and partly in the hardwood hill country. The western portions of these counties reach an altitude varying from 450 to 700 feet; but along the streams and in the more easterly portions their altitude is considerably less.

THE SEABOARD REGION.

Brunswick county has in its western part 4,000 acres of white cedar land, most of it located along Juniper creek, Green swamp and its ramifications, and 20,000 acres of excellent cypress and loblolly pine lands which have never been lumbered. The lumbered districts lie in the northern part of the county along the W. C. & A. R. R. and in the northern arms of the Green swamp, which are tributary to the Cape Fear river. Much timber has also been rafted out by way of Waccamaw river from the extreme western part of the county to the mills at Georgetown, S. C. The oak lands bordering the numerous swamps are equal in area to the cypress lands and are destined to become very valuable. The entire swamp area is 166,000 acres, one-half of which is gum

swamps and cane brakes. The cutting has been done gradually in these swamps and the young growth is in a fair condition. The long-leaf pine lands lie in the southern and central parts of the county and consist mostly of turpentine orchards either still being worked or now abandoned. There are in this county 130,000,000 feet of standing long-leaf pine.

Columbus county has in its southern and eastern parts, along Waccamaw river and the lake swamp and in Green bay, some very fine cypress. These bodies have in part been lumbered. In White and Brown marshes and in the western section of the county, along Lumber river and Big swamp, there are large tracts of unlumbered cypress lands. The total area of cypress in the county is about 32,000 acres. In Green bay swamp, from which large quantities of white cedar have already been taken, there still remains a great deal more. There are 60,000 acres of swamp lands in the county. On the level pine flats there are between ten and twenty thousand acres of loblolly pine, largely second growth, very little of which has ever been cut. The long-leaf pine lands lying in the central and northern portions of the county have 145,000,000 feet of merchantable pine standing on them.

Duplin county contains about 12,000 acres of cypress swamp along the North East river and its tributaries. Adjacent to the streams much of the best timber has been culled or picked over. The remaining merchantable cypress lies principally along North East river, Back swamp, Goshen, Lockwood and Cypress pocosins. There are excellent water oak, willow oak and swamp chestnut oak in the flats bordering the above-mentioned swamps and Angola bay. There is some ash and yellow poplar, but the wood of neither tree is here of a superior quality. Over one-half of the swamp area, which amounts to about 38,000 acres, is covered with compact forests of black and sweet gum and tupelo. The loblolly pine, which is largely second growth, occupies about 50,000 acres. There is still some rosemary pine on the more fertile lands around the smaller swamps. The quantity of standing long-leaf pine is not large, only 68,000,000 feet. This county and Pender have furnished a great deal of timber for the Wilmington mills.

Pender county.—Several of the swamps of this county are

continuations of the swamps of Duplin which lie along the North East river. Besides these there is Holly Shelter swamp, a large swamp in the eastern section of the county and extending into Onslow county. There is altogether 15,000 acres of cypress land, one-third of which has been culled, the largest and finest trees having been cut out to make drawn shingles from them. The finest cypress is located in Holly Shelter and the North East river swamp. Angola bay, lying partly in this county and partly in Duplin, covers 120,000 acres. Through this swamp there are extensive areas which have a very poor, sandy soil and are covered only with reeds and brambles and the savanna pine. There is a considerable area of water oak and swamp white oak flats bordering the swamps. The swamp area is about 160,000 acres. The loblolly is largely second growth and occupies the flat pine lands of the middle section. There are 90,000,000 feet of long-leaf pine standing in the county.

Onslow county.—Although this county has a very large swamp area, over 100,000 acres being swamp, only about 4,000 acres of it, consisting of narrow strips along the streams, can be called cypress land. Both White Oak swamp and Holly Shelter swamp are fringed with a broad belt of swamp white oak and water oak flats. At least one-third of these swamps is "gladey," being covered with gallberry bushes, or cane brakes and a scrubby growth of savanna pines, and has a soil of sand that is exceedingly barren of fertility and forests. There are no extensive areas of heavily timbered gum swamp in the county. Loblolly lands, covering 58,000 acres, occupy the greater part of the center of the county, while the long-leaf pine lies chiefly in the north-western part. There are 60,000,000 feet of the latter standing. The sand hills adjacent to the coast, formerly covered with long-leaf pine, are now almost denuded. In parts of the county near the coast there is a scattering growth of red cedars. They are, indeed, in this and Carteret counties more abundant than in any other portions of the State, but are generally found in considerable numbers on all the "banks" and islands skirting the coast. White cedar occurs in several "bays" in the western section of the county, and forms the growth of a "bay" of considerable size near the source of White

Oak river. The loblolly and cypress have been removed to a large extent from the territory drained by White Oak river. Lumbering has only lately begun, however, in other parts of the county.

Carteret county.—There is now found in Carteret county scarcely any cypress suitable for mill purposes. The loblolly pine area is about 30,000 acres, over one-half of which have been lumbered. In southern Carteret, near the coast, there are 20,000,000 feet of long-leaf pine, all consisting of timber standing in abandoned orchards. In the eastern section of the county there is an open pocosin of 80,000 acres, bordered with oak flats, but farther in only poorly timbered with savanna pine or in places entirely open.

Craven county.—Although extensive lumbering has been carried on in this county for over half a century it has large tracts of second growth of loblolly forest which have never been cut into. The long-leaf pine was first removed and was rapidly replaced by the loblolly pine, except on the high, sandy lands lying north of the Neuse river. Most of the lumber now manufactured in the county is from this latter pine, although for some mills the savanna pine furnishes a great many logs. There are nearly 200,000 acres of swamp in the county, the Dover swamp, lying in the south-western section, having an area of over 120,000 acres. This swamp is sandy, and in the interior is covered with an open growth of the savanna pine and occasional cane brakes. It has been partially lumbered. The other swamps are fringed with swamp chestnut, oak or water oak flats, which have never been cut into. Besides the swamp lands there is a great deal of loblolly pine land south of the Neuse, which has been more or less cut over. North of the Neuse the loblolly pine lands are in about the same condition as on the southern side. There are in the county probably 38,000 acres of unlumbered loblolly pine land. The supply of cypress and ash in the river swamps is nearly exhausted, Swift creek and Trent river being now the principal sources of supply.

Jones county lies between Craven and Onslow counties and is penetrated by some of the largest swamps in this region. Dover swamp lies in the northern part of Jones, and White Oak swamp covers a large part of the territory south of the Trent, which flows

through the center of the county and with its tributaries drains nearly its entire area. In the extreme eastern part lies the great pocosin of which Catfish lake is the center. This pocosin, extending eastward, occupies under different names much of the territory of southern Craven. All of these swamps in their interior have considerable tracts of land entirely untimbered, or covered with scattering savanna pines, small maples and gums, and have a large, unproductive soil of silt. They are, for the most part, bordered by extensive oak flats, though around White Oak swamp there are still large quantities of yellow poplar, ash and cypress. The cypress along the Trent river has been largely removed. The entire swamp area in the county approximates 125,000 acres. Excepting some narrow strips of sand hills lying parallel to the Trent river, which have a few million feet of long-leaf pine on them, the rest of the county consists of flat, loblolly pine lands, which have been largely cut over. There are between 25,000 and 30,000 acres, mostly lying in the western part of the county, yet in a virgin state. This county yearly supplies several million feet of logs for the mills at Newbern.

Pamlico county has 3,000 acres of white cedar swamp, partly lumbered, lying near Vandemere and along the western edge of Big Gum swamp in the northern part of the county. There are 7,000 acres of cypress swamp, over half of which are lumbered. This cypress swamp lies near the mouth of Bay river and in Gum swamp. The remaining swamp area is heavily timbered with yellow poplar, gums, chestnut oaks and water oaks. The soil of these swamps, though inclined to be peaty, is exceedingly fertile. The loblolly formerly covered all the rest of the county with the exception of a narrow strip of high, sandy land in the north-western section, which, in the character of its soil and the kinds of trees which grew on it, approached the pine barrens. There is now, however, no merchantable long-leaf pine in the county and not more than 10,000 acres of loblolly pine suitable for milling purposes. The central part of Big Gum swamp is open, covered with scattered savanna pines and an undergrowth of gallberries, huckleberries, brambles, etc.

Beaufort county.—There is some cypress along Chocowinity,

Blount and the other streams of the county, but the supply is rapidly being exhausted. The loblolly pine, which had an original area of over 100,000 acres, has been largely removed except in the north-eastern section. Much of the best oak in the county has been converted into staves for the West Indies trade.

The Pamlico peninsula, consisting of the counties of Hyde, Dare, Tyrrell and Washington, is largely swamp, having over 1,000,000 acres of swamp in it. The uplands consist of narrow strips surrounding the swamp and land which has been drained around lakes Phelps, Pungo and Mattamuskeet. Around the eastern edge of the swamp and enclosing the sound is a narrow strip of treeless sand dunes. Much of the soil of the swamp, especially in Dare, Hyde and Tyrrell, is peaty and covered with a growth of white cedar and bays. There is estimated to be about 40,000 acres of white cedar now in the swamp. The cypress acreage is not near so large as formerly, but there is still a large amount standing. The largest bodies lie in Tyrrell and Washington counties. The cypress lands, too, are the most fertile, and have to a large extent been drained and put under cultivation. Along the outer edges of the swamps are oak flats, which in Hyde are very extensive.

The northern portions of Dare, Tyrrell and Washington, bordering on the sound, have a growth largely of loblolly pine with some oak lowlands. The standing pine has been removed from over half of this area, which is about 100,000 acres. In western Dare there are also extensive tracts of pine lands which extend into Beaufort county. Much of the swamp in Washington and Tyrrell counties is thinly timbered with the savanna pine. There is a great deal of soft maple and yellow poplar scattered through the swamp, and in places on the most fertile soils are considerable quantities of hickory, both the shag-bark and white-heart hickory. Lumbering has been one of the leading industries of these counties for a great many years, the numerous canals and streams which penetrate the region affording great facilities for removing timber.

The counties north of Albemarle sound are so similar in the character of their forests and soil, and are so closely connected with each other, that they can best be described as one body. Five counties occupy this territory, *Chowan*, *Perquimans*, *Pasquotank*,

Camden and *Currituck*, lying from west to east in the order named. All except Chowan are penetrated in the northern parts by the Dismal swamp, or arms of it which lie on the boundary between this State and Virginia. About 65,000 acres of Dismal swamp area lie in these counties. Although the swamp varies a great deal in character of soil, most of it is peaty and was formerly covered by a heavy growth of white cedar. All of this cedar swamp has been lumbered, except about 8,000 acres, and about 8,000 acres have been repeatedly burnt over, effectually destroying all trees, and in places burning out the soil to a great depth. There were some narrow tracts of cypress in these swamps, and also in the swamps along the streams, but the cypress, like the white cedar, has been largely removed. These streams rise in the Dismal swamp and flow southward, cutting this territory into long divisions, forming the natural boundaries of the counties and convenient water-ways for removing timber along them. Oak was at one time abundant, but the finest has been cut out for staves and to supply the Norfolk navy yards. The finest pine also was removed many years ago for use in the navy yards.

The construction of two canals, the numerous natural water-ways, and later a railroad crossing these at right angles, associated with the nearness of Norfolk and the facilities offered there for the shipment and marketing of lumber, had, as early as 1850, built up a large trade in timber and lumber from these counties. The lumber which is now manufactured is almost entirely from the loblolly pine. During the past decade there has been shipped from this section in the log over 800,000,000 feet board measure, while nearly as much more has been sawn by local mills; but such is the wonderful recuperative power of the loblolly pine forests on a suitable soil that now there remains not less than 25,000 acres of merchantable pine. The production of timber in these counties is, however, not one-half of what it was ten years ago, and sooner or later the annual output will be reduced to the increase in the forest by the growth each year.

These regions around the Dismal swamp were about the southern limits of the economic distribution of the holly, the trees reaching here a large size. Large quantities of holly, dogwood and soft

maple have also been removed, but there is still a great deal left. Some sandy ridges near the middle of these counties were once covered with long-leaf pine, but there are scarcely any trees of it left now. The area of these counties is 750,000 acres, over 95,000 of which are in swamps. The savanna pine is found at intervals through the swamps, and extends into Southern Virginia, as does the tupelo gum. Some of the cypress lands are largely timbered with gums. The soil, for the most part, is sand or a sandy loam, but in the Dismal swamp, where it is not peaty, it is usually composed of fine silt. The timber lands of these counties have, as a rule, been more thoroughly lumbered than any others in the State.

THE INLAND LOBLOLLY PINE REGION.

GATES COUNTY, like the region just described, lies on the Virginia line, and has the extreme eastern part lying in the Dismal swamp. The Chowan river, which forms the southern and western boundary of the county, has along its entire course a narrow swamp. There are 20,000 acres of white cedar lands in this swamp and several thousand acres in the Dismal swamp which are untimbered. The little cypress still standing in the county lies along Bennett's creek. Loblolly pine, which occupied the central and eastern parts of the county, growing on a sandy loam, has been removed, except between ten and twenty thousand acres which are in small tracts. In the western part of the county is a high sand ridge resembling the pine barrens. The long-leaf pine has been removed from this and an open growth of loblolly and short-leaf pine with black-jack beneath them has taken its place. In the extreme north-western portion there is a strip of bright-colored loam soil, timbered with a heavy growth of post, black and red oaks. Most of the timber cut from this county is transported to Virginia.

HERTFORD COUNTY is the first of a number of counties lying in the pine uplands which has no large swamps. The eastern and southern parts of the county have a sandy loam soil, in places silty and very compact, which was covered with a dense loblolly pine forest, now largely lumbered, through which were interspersed narrow strips of white and red oak lands. In the northern part of the county there is more oak and dogwood mingled with the pine.

There are about 25,000 acres of unlumbered loblolly pine land. The cypress, which is confined to the alluvial land along the streams, is more abundant along the Ahosky and Pottecasy than any other streams.

Bertie county has a soil and growth similar to those of Hertford county, consisting for the most part of upland loblolly pine lands. In the southern part, however, it is skirted by the Roanoke river, which is bordered with a broad swamp still having large quantities of white and red oaks, gums, maple, cottonwood, hickory, sycamore and elms and some ash and cypress in it. There is also some cypress along Cashie and Roquest creeks. Although the timber yield of this county has been very large for a number of years there are now standing 65,000 acres of unlumbered loblolly pine. Early in this century Bertie county was known as the "pine forest," on account of the density and excellence of its forests of this tree.

Martin county lies south of Bertie on the opposite side of the Roanoke. Its soil is similar to that of the last described counties, but the Roanoke river swamp is less continuous, being confined to several bends in the river in the eastern part of the county. Along the river there are some narrow sand ridges, now covered with black-jacks and small post and red oaks. The remainder of the forest area is loblolly pine land, about two-thirds of which has been cut over. The county is the seat of extensive milling operations.

Pitt county, being drained in the northern and eastern parts by the Tar river and Grindle creek, one of its largest tributaries, has for many years furnished large quanties of timber for the mills at Washington. Along all the streams are large stretches of cypress swamp and oak lands, the latter forming virgin forests and the former only partially lumbered. The loblolly pine near the larger streams has been extensively cut. In the southern and western sections the soil becomes more sandy, and the original growth, longleaf pine, has been replaced by loblolly pine, mixed with a low growth of oaks. The loblolly has never been removed from this section.

Greene county, which lies just south of Pitt, has in the northern parts a soil similar to that of the adjacent portion of Pitt, and

North Carolina State Library.

is covered with similar forests. In the southern section the soil is more sandy and there are numerous sand hills, approaching the pine barrens, now nearly denuded of the long-leaf pine, which was once abundant, and largely covered with sand black-jacks. Along Contentnea creek and its numerous tributaries, which drain the entire county, are extensive tracts of cypress swamps. In the northern part of the county these swamps, which extend over into Pitt, have been but little lumbered; in the central portion, however, exploration has been carried farther. About one-half of the forest lands, or 30,000 acres, is still covered with merchantable loblolly pine.

Edgecombe and Wilson counties lie west of those last described and have an average elevation of about 50 feet higher than that of these counties. Their soil is considerably drier and more sandy than that of the section to the east of them, being a sandy loam, which in places passes almost into sand. The long-leaf pine, which primarily occupied these lands, has been largely destroyed and a scattering growth of loblolly pine, with an undergrowth of low post and red oaks and dogwood or thickets of black-jack oak, have taken its place. There are along the streams occasional strips of cypress swamp which have not been lumbered and there is a considerable quantity of other swamp timber, sweet and black gums, tupelo, soft maple, and occasional overcup and chestnut oaks. Although over one-half of the area of these counties is under cultivation, there is still standing a considerable quantity of merchantable loblolly pine.

Wayne, another of the loblolly pine counties, has in the section contiguous to Wilson county a soil and forest similar to those of Wilson, but south of the Neuse river, which flows through the centre of the county, there are extensive tracts of pine barrens, stripped of pine and covered with sand black-jack oak or completely denuded. Skirting the Neuse river and its tributaries are tracts of swampy alluvium, on which there are still merchantable gums and oaks, and in places cypress and ash. The loblolly pine (rosemary), which was once abundant along these lands, has for the most part been removed. There are several small white cedar "bays" at different places in the county. The loblolly pine, except

that along the streams, is all second growth and forms open forests. About one-fifth of the wood land, or 30,000 acres, is loblolly pine fit for mill timber. When removed this loblolly pine is apt to be succeeded by small oaks. There are now standing in this county probably 30,000,000 feet of scattering long-leaf pine.

Lenoir county is situated on the Neuse just below Wayne, and its swamp lands along the Neuse are of the same character and in a similar condition. The extreme southern and western parts of the county are very sandy, and in places on the ridges there are important bodies of long-leaf pine, or black-jack oak, which in places has replaced it, while between the ridges there lie very narrow alluvial or peaty bottoms covered with a growth of swamp timbers. Scattered through the county are plains, at times inundated, on which there is a growth of oaks, maples, elms and ash. The eastern section is flat loblolly pine land covered with a heavy growth, except near the river; but there are scattered through this loblolly pine forest small pocosins covered with savanna pines and a variety of shrubs. There are about 30,000 acres of loblolly pine and 30,000,000 feet of standing long-leaf pine in the county.

Johnston county lies west of Wayne and is also drained by the Neuse. Along the river and its numerous tributaries there are the usual strips of swampy alluvium covered with swamp timbers. In the eastern and southern parts of the county the soil is a sandy loam, which becomes more loamy toward the north and west, and the surface in these sections is more rolling and hilly. The timber on this loam consists of long-leaf pine, mixed with oaks and loblolly pine, and in the southern section near the river there are quantities of valuable loblolly pine. There has been very little milling done in the county, but considerable timber has been rafted to mills down the river. The long-leaf pine is being very rapidly replaced by the loblolly pine, the amount of the former now standing being only about 160,000,000 feet.

THE PINE-BARREN REGION.

In Robeson county there is along the dark loam lands of the Lumber river 28,000 acres occupied exclusively by the loblolly

pine. This pine is in all stages of growth, and is gradually taking the place of the long-leaf pine as the latter is being destroyed by forest fires or otherwise. Many of these tracts covered with loblolly pine appear, however, to have always been occupied by this tree which here forms, on soil sufficiently moist and loamy, small clumps of unmixed growth frequently 100 acres or more in extent. These trees are coarse-grained, largely of sap wood, and are from two to two and one-half feet in diameter. None of these have ever been cut for lumber. In Big swamp there is probably 5,000 acres of loblolly pine, which is largely of the *rosemary* variety, mixed with large gums and cypress trees. Only a part of this swamp has been lumbered. The area of the gum and cypress swamps is about 30,000 acres, lying in Big swamp and its tributary marshes, Flowers swamp and the other swamps along Lumber river. There has been very little lumbering done in them. There are no extensive oak flats in the county and little ash or poplar. On the long-leaf pine uplands, lying in the southern and northern sections of the county, there are 280,000,000 feet of merchantable timber. The pine lying immediately along the railroads has been to a large extent removed.

Bladen county has about 12,000 acres of cypress land lying along Brown marsh, Big swamp, Cape Fear river, Colly and Turnbull creeks. About 4,000 acres have been more or less thoroughly lumbered; and there are about 3,500 acres of white cedar swamp, which have to a large extent been cut over, but were left in a fair condition. This latter lies in Big Juniper bay and various smaller bays on the north side of the Cape Fear. There are large tracts of untouched oak flats and gum swamps mostly in the southern and western parts of the county. Good ash, except in the smaller swamps, is becoming scarce. This county has a swamp area of about 55,000 acres. The loblolly pine, except along the swamps, is usually scattering. There cannot be less than 10,000 acres occupied by this pine, only the finest and largest trees having been removed. The long-leaf pine lands of Bladen have been very badly treated. On either side of the Cape Fear river there are extensive tracts of "pine barrens," on which this pine has been very largely destroyed, so that it is really waste land. But there

is still about 308,000,000 feet of standing long-leaf pine, lying chiefly in the western and southern parts of the county.

New Hanover county lies immediately on the coast, and consists largely of pine barrens. The long-leaf pine has been for the most part removed or destroyed. There are still, however, several million feet standing in different parts of the county. In the northern part along the North East river there is some swamp land timbered with gums and some oak. Smith's island, which lies at the southern extremity, is densely timbered with a growth of hardwoods, largely water and live oaks, interspersed with palmettos.

Cumberland county, like the northern part of Bladen, lies largely in the sand-hill region and contains considerable areas of "pine barrens," from which the original long-leaf pine forests have been removed. In the eastern part of the county there is some white cedar along the streams or occupying small swamps, and along most of the deeper streams there is cypress. There are no extensive bodies of merchantable oak or loblolly pine to be found. In the eastern part of the county the long-leaf pine has been largely cut out, but west of Fayetteville it forms extensive forests, extending nearly to the Moore county line; and there are probably 310,000,000 feet of standing long-leaf pine in this region.

Harnett county is situated north of Cumberland, and that part of it lying south of the Cape Fear river, which divides the county into northern and southern halves, is a continuation of the rolling sand-hill country with its pine barrens of Cumberland county. The larger part of these pine lands is in an exceedingly bad condition, having been burnt over until there are extensive tracts entirely denuded of all tree growth. There is very little cypress to be found in the county. North of the Cape Fear river the country merges into the dark loam uplands covered with a young growth of oaks, dogwood and loblolly pine, which are replacing the long-leaf pine. There is only about 200,000,000 feet of long-leaf pine now standing in the county. Harnett county furnishes some timber for the Wilmington market, last year it having been estimated that about 1,500,000 feet, board measure, of long-leaf pine timber was rafted down the Cape Fear river.

Sampson county.—The oak lands of Sampson lie in the northern part of the county and are covered with a growth of young white and post oaks. There are no large bodies of water or chestnut oak flats. The cypress and gum swamps lie in narrow strips along Black river and Big and Little Cohary creeks. The unlumbered cypress lands cover about 3,800 acres, and about an equal area has been cut over to obtain timber for the Wilmington market. The long-leaf pine lies chiefly in the southern and central parts of the county. The standing pine amounts to about 330,000,000 feet. The loblolly pine, largely second growth, is scattered through all sections of the county and occupies about 35,000 acres. This county has for many years furnished a large part of the timber that is carried to Wilmington.

Richmond county.—The larger portion of this county may be described as being typical sand-hill country, the surface being undulating and even hilly, and the soil sandy; the sand often being many feet deep. In the extreme western part there is along the Pee Dee a narrow strip of alluvial swamp, heavily timbered with red, overcup and chestnut oaks, red maple and hickory. In the eastern part of the county there are white cedar, gums and cypress of inferior quality along the streams. The long-leaf pine which covers the remainder of the county has, over the larger areas, been removed when adjacent to the railroads. Lumbering is, however, largely carried on in the northern part of the county at the present time, and extensive bodies of timber still remain there and in the eastern section. There remains probably 220,000,000 feet of standing long-leaf pine.

Moore county lies north of Richmond and has in the southern part, along the sand hills, a similar soil and topography. This section, embracing the southern two-thirds of the county, is covered with long-leaf pine and is the seat of the largest long-leaf pine industry in the State at the present time. In the middle portion of the county, where the soil is more loamy, there is considerable post oak and small hickories mixed in with the pine along the hill-sides and yellow poplars and a few loblolly pines along the lowlands. The northern third of the county has a loamy soil covered with a growth of hardwoods mixed with long-

leaf and short-leaf pines. Although extensive lumbering operations have been carried on in these pineries for the past fifteen years, so that all timber near existing lines of railroad has been removed, there are probably 320,000,000 feet of long-leaf pine still standing in the county. The long-leaf pine is succeeded in this county, as is the case in Richmond, by sand black-jack oaks. In the very sandy parts of the county there is only a little loblolly pine, with small cypress trees and some white cedar scattered along the streams.

THE TRANSITION REGION.

Northampton county is situated on the boundary between the loblolly pine uplands and the hardwood hills which cross the western third of the county. The loblolly is mixed in places with scattered short-leaf pine, and is, except along the swamps and streams, very largely a second growth. It has never been lumbered. The southern and western boundary of the county is the Roanoke river, and along its entire course there is a strip of alluvial swamp from one to three miles wide, covered where there have been no clearings made with a heavy growth of trees similar to that along the same river in Bertie county (p. 20).

Halifax county.—The eastern half of Halifax county, like the greater part of Northampton, is a fairly level region, with an average elevation of but little more than 100 feet above sea-level. The soil is generally a sandy loam, and the forests of this region consist mainly of loblolly pine with the short-leaf pine, post oak, spanish and white oak interspersed. On the northern boundary of the county along the Roanoke river lowlands, which are of less extent on this side of the river than on the northern side in Northampton county, are at intervals forests of black gum, sweet gum, red maple, elm, red oak, ash, sycamore, hackberry, and other deciduous trees. Occasionally one finds on portions of these fertile lowlands, the cultivation of which ceased some fifty years ago, vigorous but scattering black walnut trees nearly 2 feet in diameter and more than 50 feet high. Beech creek, likewise, with its larger affluents, Marsh and Beaver Dam creeks, have along their courses some ash, cypress, gums and tupelo, and these streams are bordered in places with extensive flats of scarlet, chestnut, overcup and willow oaks. The

western half of the county is quite hilly, as are also the western portions of Northampton and Nash counties. The soil, while sandy, gravelly and pebbly in places, is in general much more clayey than that of the eastern section. The forests of this western half of the county are mostly oaks, hickories and other hardwood trees, with a few scattering short-leaf pines.

Nash county has a soil and topography much resembling those of eastern Wake, being a rolling country, hilly along the larger streams and having a light loam soil. The growth, also, is like that of Wake, consisting of scattered long-leaf pines, about 20,000,000 feet, board measure, standing, which is rapidly being replaced by loblolly, or on close soils by oaks, dogwood and hickories. The long-leaf pine extends west to the clay hills; on which the hardwoods of the uplands are mixed with short-leaved pines. There is more loblolly pine here than in Wake, both original growth and second growth. There has been very little lumbering done in the county except immediately along the lines of the railroads.

Montgomery county, lying west of Moore, has in the eastern part, on a loam soil, a heavy growth of long-leaf pine which has never been lumbered. This growth toward the middle of the county is mixed with short-leaf pine and hardwoods, and there the hardwood uplands begin. This is the finest body of pine for lumber now in the State, having been worked for turpentine for only four or five years. There are 338,000,000 feet of long-leaf pine in the county and about 40,000,000 feet of short-leaf. There are some extensive bodies of hardwoods in the Uwharrie mountains in the western section.

Chatham county now has an inconsiderable amount of long-leaf pine in the extreme south-eastern section. Its place has been taken as it was removed by a heterogeneous growth of oaks and the short-leaf pine. In the middle part of the county there are along the ridges short-leaf pines and hardwoods, while the lowlands along the Haw and the Deep rivers are timbered in most places with oaks, maple and loblolly pine.

Wake county has in the eastern part considerable long-leaf pine still standing, mixed with a young and vigorous growth of oaks and dogwood. The soil is for the most part a reddish loam, inter-

spersed with sandy ridges, on which the long-leaf pine, where it has not been replaced by black-jacks, is more abundant than on the loam. There are 30,000,000 feet of this pine standing. East of the center of the county the short-leaf pine appears, and from there westward it is the commonest old-field pine. There is a very large acreage of both second growth short-leaf and loblolly pines in the county and probably 60,000,000 feet of their original growth standing in the eastern section. To the north and west of Raleigh the surface is more broken and the oak growth more abundant, except along the gravelly ridges, where there is short-leaf pine. West of Wake the loblolly pine becomes less frequent.

EXISTING SUPPLY OF TIMBER IN EASTERN NORTH CAROLINA.

In conclusion, it can be said that certain kinds of timber, both useful and abundant, are as yet of little commercial importance in most parts of the coastal plain region. Such are water, willow, overcup and chestnut oaks, sweet and black gums, soft maple and sycamore. The supply of some other kinds of timber, such as ash and holly, has been nearly exhausted.

There are still large quantities of *cypress* standing in some counties, while in others the supply has been almost exhausted. This tree is of very slow growth and shows little tendency to reproduce itself abundantly, the regrowth after it has been removed generally being sweet and black gums. The soil of cypress swamps is usually one of the best of swamp soils and when drained is very productive; so these swamps are being put under cultivation. Considerable areas have already been reclaimed for agricultural purposes, and a great deal more is to be thus reclaimed in the near future. It is evident from this that in this State there will never be any general second growth of cypress to take the place of that which is now being removed.

White cedar, which usually occurs with white bays in small swamps or in clumps in other swamps, flourishes only on a peaty or very sandy soil which is largely mixed with organic matter. These soils are unfit for agricultural purposes and their fertility is easily destroyed by fire during very dry seasons, especially where

the dried *debris* resulting from logging fills the woods. Unless these swamps are burnt out a growth of the same species is most likely to replace the white cedar after lumbering, but in the event of a fire the white bay (*Magnolia glauca* L.) will succeed and usually retain possession. Although white cedar is very valuable, grows rapidly, and there is only a comparatively small amount in the Eastern United States, these swamps are from carelessness frequently burnt and the chance of a regrowth thus destroyed.

The *loblolly pine*, now generally recognized as a valuable lumber tree, is the dominant pine over a large area, and has been removed from only a relatively small part of the territory it occupied. It is a tree of rapid growth which seeds abundantly and usually follows itself after lumbering. Oak occasionally replaces it as the hardwood uplands are neared. However, on account of the destruction of a great part of the young growth, these second growth forests are never as dense as they should be. This produces less timber to the acre and is the cause of many deformities, as knotty, crooked and short-stemmed stocks. The loblolly pine is also taking the place of the long-leaf pine in the forest on moist soils, and on drier soils when the latter have been under cultivation. The standing merchantable loblolly pine can be said to cover about 1,150,000 acres in the eastern part of the State. Allowing a cut of 4,000 feet, board measure, to the acre, this will make 4,600,000,000 feet of standing loblolly pine. At the present rate of cutting, 290,000,000 feet, board measure, having been reported as cut during 1893, this would last fifteen years. The final amount cut will, however, be much larger than this, since in the meanwhile there will be a constant increase each year in the amount of young growth available for milling purposes and a considerable increase in the size of the merchantable pine now standing. The entire acreage of loblolly pine land, including the lumbered areas with second growth on them, the unlumbered and lands where it is taking the place of the long-leaf pine, is considerably over 4,000,000 acres.

There are possibly 300,000,000 feet of the *savanna pine* in pocosins and around the edges of swamps and nearly as much *short-leaf pine* situated in the counties bordering the oak uplands. Most of this will be lumbered along with the loblolly pine.

The total amount of merchantable *long-leaf pine* now standing in the State is about 3,103,000,000 feet. The estimate of Mr. Kidder, of Wilmington, N. C., prepared for the United States Census Department, fixes the amount of timber, standing, on May 31, 1880, in the counties south of the Neuse river, at 5,229,000,000 feet. This, compared with the amount now standing in the same counties, shows a decrease of 2,000,000,000 feet in the amount of merchantable pine in thirteen and one-half years. At this rate of decrease in less than twenty years the long-leaf forests will be a thing of the past. The rate of decrease is, however, one of constant acceleration, since the yearly output of the mills is increasing and there is a much larger amount of abandoned orchard at the mercy of wind and fire.

At the end of twenty years there may remain scattered bodies of this pine remote from transportation facilities or too small to be profitably sawn, but there will be nothing more. The length of time the long-leaf pine will last can be stated with more certainty than in case of the loblolly pine, because in the case of the former there is no appreciable addition of merchantable timber from second growth woods.

The total amount of merchantable pine of all kinds (*loblolly, long-leaf, short-leaf* and *savanna*) in these Eastern North Carolina counties can be placed at about 8,200,000,000 feet, board measure.

The amount of standing swamp timber cannot be estimated with any degree of accuracy, since no average can be arrived at for the cut per acre, and only approximate figures can be gotten for the acreage. Cypress, for instance, will cut from 500 to 5,000 feet to the acre as a general thing, but numerous reports were made by trustworthy lumbermen of cuts running from 15,000 to 20,000 feet to the acre. There is a very wide range given for the amount of white cedar to the acre, but not so wide as that for cypress. The water oak and chestnut oak lands usually have a more uniform growth, and will cut from 1,500 to 3,000 feet to the acre. One of the chief difficulties connected with the handling of this oak, where such has been attempted, is that when green it has a greater specific gravity than water and cannot be floated out unless rafted with lighter woods. The same is true of the elm, hickory and much of the gum.

CHAPTER III.

THE WASTE LANDS OF EASTERN NORTH CAROLINA.

It is a very generally received opinion that the eastern part of North Carolina, especially that part covered with the long-leaf pine, is so densely wooded that for very many years at least there will be there not only an abundant supply of timber, but of a timber of the very finest quality. The long-leaf pine for nearly two hundred years has fully supplied all demands, not showing until very recently the least sign of failing. During the period between 1860 and 1870 the timber of the "pine barrens" was treated in a most reckless manner, and the fires which passed through them left traces which will last for many years to come, burning thousands of acres as clean as if they had been placed under cultivation. The timber which suffered most was that on the highest and driest land, where the ground was covered beneath the trees with a thick growth of wire-grass (*Aristida stricta* Mx.) and such broom grasses as grow on dry, sandy soil (*Andropogon tener* Kunt. and *A. Elliottii* Chap.).

The 3,100,000,000 feet of merchantable long-leaf pine still standing might seem to be sufficient to last for building and fence material in districts not readily accessible to large lumbermen for an indefinite time. But this is not so. The fact that since 1873 the output of turpentine in this State has fallen off over one-half, which of itself gives a very vivid idea of the number and extent of the turpentine orchards that have been abandoned, shows that it is now only a question of a few years before the turpentine yield will be reduced practically to nothing. This will mean that all the orchards have been abandoned, and it will be only a short time after their being abandoned before the destruction of the timber takes place, either by fire or by its being blown down, or by the two agencies combined.

The greater part of the dry upland soils of the pine belt are of two kinds: (1) the sandy loam soils of the level piney lands, and (2) the sandy soil, of nearly pure deep sand, characteristic of the

pine barrens of the sand-hill regions. These barrens are dry and frequently form large tracts of rolling or even hilly land.

The first of these soils is not unproductive and is well adapted to agriculture; and as the original growth of long-leaf pine is removed from it the loblolly pine and a small growth of different kinds of oak, mostly the post, Spanish and black oaks, take its place. In the pine barrens, on the other hand, no oaks will flourish except two very small, worthless trees, the sand black-jack and the "barren" willow oak, and no pine except the long-leaf pine. Unless the soil has been previously cultivated the loblolly pine does not take posession of these lands, even when there are numerous trees of this species standing near by in wet places. From this it follows that when these high sandy lands are being stripped of their original growth of long-leaf pine, if its young growth is not allowed to develop, no tree of economic importance will naturally take its place. The sand black-jack oak in twenty years will have matured and begun to decay, while in that time a pine has only fairly begun its life, although its usefulness, even then, will be much greater than that of the more quickly maturing black-jack.

There are few uses to which the black-jack can be put. Its small size excludes it from being employed in construction; in contact with the soil it decays rapidly, and so is unfit for fence posts. It makes a very good fire-wood and is largely used for this purpose in Wilmington, Southport and other towns, and also in the country. Its bark is said to be valuable for tanning, but although the growth of this tree covers a very large area it is doubtful if the yield of bark per acre would be sufficient to make it of any commercial importance. The upland willow oak is even of less importance than the sand black-jack. While the presence of these trees is not pernicious, and is in fact much more beneficial to the land than would be a state of entire denudation of all forest growth, yet their growth is not near so valuable as that of the long-leaf pine, and the advantages arising from their presence are greatly inferior to those derived from a forest of the long-leaf pine of the same age. For this reason every means should be taken to enable the long-leaf pine to regain a firm hold on all high sandy land

which has now on it no growth at all, or none of greater worth than the two oaks just referred to as growing on these lands.

SCARCITY OF TIMBER IN THE SAND-HILL REGIONS.

The exhaustion of the long-leaf pine forests is not a concern of the distant future alone,—something to be talked about and never to be realized. There are already localities, of limited area, to be sure, where there has never been a lumber mill, and with not one-tenth of the land under cultivation, where there is not now sufficient timber to properly fence the fields. The district around White Hall, Bladen county, is such a one, and this place is in the very centre of the long-leaf pine belt. Here good pine for fencing has become so scarce that a "stock law" or "no fence law" has been secured by which all live stock is to be confined to the Cape Fear river bottom, and that alone, fenced in across a bend of the river. There are other localities in Bladen, Sampson and Cumberland counties with about the same proportion of land under cultivation that find it hard each year to secure rails necessary for fence repairs, and obtaining them becomes annually more difficult as the forests from which the material is procured diminish in size. It is usually the case that some tree succeeds this pine as it is gradually cut off or otherwise destroyed, and this tree is usually the sand black-jack, and it forms over the land where the pine has once been a thicket of low, scrubby trees, which in less than twenty years will die and be replaced by a similar growth.

Scattered among these scrubby oaks are frequently stunted, knotty long-leaf pines, with a thin, sickly foliage of yellowish green, which are permitted to stand because they are regarded as useless. There are also large tracts of land on many acres of which there are no pines at all, and others where the black-jack even has not succeeded in getting a foothold, wire-grass and a few bushes being the extent of the vegetation.

THE LARGER TRACTS OF BARREN LAND.

Bladen county has its largest tract of this barren land in the northern part of the county, between the Cape Fear river on the

south and Black river on the north-east, extending eastward as far as Lion swamp and west nearly as far as Parkersburg. It is about 18 miles long and from 4 to 10 miles broad, and has almost 70,000 acres of waste land in it. There are on it, however, a few bodies of pine in excellent condition, which either have not been boxed, or if boxed have been carefully protected; but for the most part it is covered with a scanty growth of sand black-jack, beneath which there is a great deal of densely tufted wire-grass, though in places there are only lichens and moss on the ground, or sometimes stretches of dazzling white sand. Here and there are small long-leaf pines, exhausted by the continued boxing.

In depressions where the soil is wet there are gallberry "bays" in which are a few savanna pines, but there is no loblolly pine except bordering the larger streams. These streams having loblolly pine along their banks are the Black and Cape Fear rivers, Colly swamp, Johns and Turnbull creeks. Colly swamp and Johns creek have in places a rich deep soil, formed of a fine silt largely mixed with organic matter, and could be easily drained. The drainage of Colly swamp for agricultural purposes is now being undertaken and it is probable that most of the swamp land will ultimately be drained, since it is much more fertile than the sand-barren uplands. This will mean, of course, the removal of the swamp timber. Although these streams have loblolly pine along their courses, its seed has never produced a young growth on any of the neighboring high sandy land; so that when the swamp timber is exhausted there will in reality be a dearth of building material throughout this region. The long-leaf pine timber from the tract was largely taken off to supply the mills at Wilmington, though much of it has been destroyed by fires. Even now some long-leaf pine timber, of an inferior quality, is obtained from here.

The surface of the land is gently rolling; the soil is nearly pure sand, with a small percentage of other mineral matter in it, and the subsoil, which is a light yellow sandy loam, lies too deep beneath it (from 8 to 15 feet below the surface) to be reached by the roots of trees. Generally there is no humus, the constant fires burning off the leaves and dead grass soon after they become dry. There are in Bladen county several smaller tracts of waste land, which lie south of the Cape Fear river.

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In Sampson county there is, perhaps, no single tract of waste land which covers an area as large as 10,000 acres. But beginning in the south-western section of the county, near Autryville, and following the Black river down, there are several small areas of from 3,000 to 8,000 acres, all of which areas are in a bad condition. These have been burnt over and in many instances are still covered with charred stumps or encumbered with fallen trees. The surface sand here is not as deep as in Bladen, the loam usually lying about three feet below the surface; nor is it as continuous, being cut across by Big swamp, Big and Little Coharie, and by several other swamps and streams. The population here is thicker than on the southern side of the river, and there is more cleared land, but there is as yet no scarcity of good timber. As the trees are here worked for turpentine longer than elsewhere in the State there are less abandoned orchards and the forests are better protected. The combined area of all the waste tracts in this county amounts to about 25,000 acres.

Cumberland county has in its eastern part a continuation of the sand-hills of northern Bladen. The land in some places is more hilly, and the loam subsoil lies usually at such a depth below the surface (5 to 20 feet) that the roots of many trees do not reach it. The waste land lies mostly east of Fayetteville, all along Rock Fish creek, and south and east of Manchester. There are, however, many bodies of excellent timber in this latter section of the county. Along some of the creeks in the south-eastern part of the county the land is almost bare of all tree growth, while in other places, particularly in the north-eastern part, there is a heavy growth of sand black-jack, which has an average height of about 15 feet. There are at least 40,000 acres of such barren land in Cumberland county. Although not one-tenth of the soil is under cultivation several reports from the county state that in many places fencing material is becoming scarce.

Timber, other than the long-leaf pine, is not abundant in most parts of the county. The streams all have narrow channels and there is not much hardwood or loblolly pine along them. There are several white cedar "bays," but these can supply no building material. West of Fayetteville there is the same kind of soil that there is in the eastern part of the county, but there is much

more timber standing. This part of the county is a succession of sand ridges and sand hills, which are covered with a fair growth of long-leaf pine. Nearly or quite all of this pine has been boxed, and although a considerable amount of lumbering has been done there remain large areas of valuable pine forests.

HARNETT COUNTY has in its southern parts a large area of waste land, which is in a worse condition than any other such tracts observed in the State. This is what is called the "Thomas Strange tract," which extends from the Lower Little river on the south to Little river on the north, and eastward 15 miles from Swann Station, on the C. F. & Y. V. R. R. This tract contains over 40,000 acres of waste land, two-thirds of which has but few merchantable pines on it and scarcely any sand black-jack. All of this except the part immediately adjacent to the railroad was reduced to its present condition by repeated forest fires, the thick wire-grass forming the fuel which carried the flames. The territory along the C. F. & Y. V. R. R. has been lumbered and there is still some lumbering operations going on along it where there are bodies of timber which have been protected from the fires.

The topography of the southern part of Harnett is similar to that of Cumberland. It is a typical "sand-hill" region, and its soil is sand with the loam lying very deep below the surface. The streams usually have narrow channels and very little hardwood or loblolly pine along them; but along Upper Little river and the Cape Fear there are in places wide and well-timbered "bottoms." The northern part of the county has a salmon-colored gravelly loam soil on which loblolly pine and white oaks are replacing the long-leaf pine. In the western part of the county and extending east from Jonesboro there is another tract which was burnt over several years ago and much of the timber on it destroyed. This latter area is not "waste land" now, but it soon will be. Harnett county, being intersected by the Cape Fear river and two of its largest tributaries which afford transportation facilities, furnishes yearly a considerable amount of timber (long-leaf pine) for the Wilmington mills.

MOORE COUNTY has 60,000 acres of waste land, all of which has been recently lumbered, though much of it has been burnt off subsequently. This land has a heavy growth of young sand black-

jack on it, and in the localities more recently lumbered there remain a few scattered pines. It lies in the eastern and southern parts of the county, along the railroads. In places there are some post and spanish oaks with the sand black-jack oak, but there is almost no loblolly pine and no other material suitable for building purposes except the long-leaf pine. When lumbering has ceased there will probably be over twice the area of waste land there now is, since all the southern section of the county is high rolling pine barrens, with a deep sandy soil.

Richmond county has a soil in character similar to that of the southern part of Moore; but since lumbering has not been so extensively carried on in Richmond as in Moore there are in the former only about 40,000 acres of waste land, all of which have been lumbered except a few small tracts which have been burnt over. This waste land lies along the C. C. and R. & A. R. R's. It is covered with a thick growth of sand black-jack oak, and there are undersized pines scattered over a part of the area, many of them still being worked for turpentine. Except the long-leaf pine there is very little timber in the eastern part of the county suitable for building material.

Robeson county has very little waste land and very little deep sand except in the northern part of the county. In that section, adjacent to the Cape Fear river, there are possibly 10,000 acres with little tree growth except sand black-jack oak. In the middle and southern parts of the county the loblolly pine is taking the place of the long-leaf pine.

Brunswick county contains several thousand acres of waste and very thinly timbered lands along or near the sea-coast and the Cape Fear river. While these lands were never heavily timbered they are now rapidly getting into a deplorable state, which is a presage of the final destruction of the long-leaf pine.

Columbus county has about as much waste land as Brunswick. This land is in small tracts lying in the southern part of the county and the sand black-jack oak has taken possession of most of it. Good loblolly pine is, however, abundant through most sections of this county.

Wayne county has 20,000 or more acres of waste land covered

only with sand black-jack oak and very scattering, exhausted long-leaf pines. This land lies in the central and southern parts of the county. Good timber is getting scarce in many places. Much of this sandy land in this and other counties has been highly fertilized and is cultivated in truck farms, vineyards and fruit orchards.

Duplin county contains several thousand acres, in the northern part, covered only with the sand black-jack oak, through which, occasionally, there occurs a few scattering long-leaf pines. Near the railroads a great deal of this sandy land, which has been highly fertilized, is used in this county for truck gardening.

Onslow and New Hanover counties have jointly about 25,000 acres of waste land, some of which is entirely denuded and some covered only with the sand black-jack oak. In many parts of New Hanover county, especially between Wilmington and Wrightsville, there is a very promising regrowth of long-leaf pine appearing, though the trees are very scattering and fires destroy a great many of the smaller ones every spring. The growth of timber in the eastern parts of New Hanover and Onslow counties, like that in the eastern part of Brunswick county, was probably never dense.

Besides the above tracts there are in *Johnston*, *Pender* and *Lenoir* counties a few smaller tracts which have been stripped of the long-leaf pine and on which no valuable regrowth has appeared; and there is immediately along the coasts of *Currituck*, *Dare* and *Carteret* counties a narrow strip of land which in many places is entirely bare, and has been described by the late Prof. W. C. Kerr as forming drifting sand dunes, which, along the coast of Dare county, "are moving under the impact of the trade winds constantly toward the south-west into the sound." What effect these moving dunes may have on the existing channels in the sounds or how they may modify or change the inlets between the sounds and the ocean are questions foreign to the present subject.

It is a well-known fact, however, that the breaking of the ocean, in 1763, through one of these untimbered sand banks formed the *New Inlet*, 16 miles below Wilmington, N. C., and seriously changed the channel at the mouth of the Cape Fear river, lessened the depth of its water and caused the expenditure of a large amount of money before the damage done could be rectified and the break

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securely filled. It could not be learnt whether this strip of sand dunes was ever timbered, though it is probable that at one time it was, since Smith's island and other parts of this same bank only a few miles distant are now heavily timbered.

THE ORIGIN OF THE WASTE LANDS.

From the preceding it appears that there is a large amount of waste land lying in the south-eastern part of this State. There are now over 400,000 acres of such land and the amount of it, from various causes, is constantly increasing. This land consists of high, rolling or hilly sand barrens, formerly covered with extensive forests of long-leaf pine. These forests yielded turpentine abundantly, but on account of the larger amount of sapwood and the coarser grain of the wood of trees growing on these poorer sandy lands the lumber, though of good quality, was of a grade inferior to that from trees grown on fertile soils. Now, however, owing to the grossest neglect, large portions of these forests have either been destroyed entirely or reduced to such a condition that there is neither mill nor turpentine timber on them, and no regrowth of the long-leaf pine has been allowed to take the place of the older trees as the latter were being gradually exterminated. The soils of the barrens on account of their sandiness and poor quality will produce very few kinds of trees which have any economic importance. No valuable broad-leaved trees (oaks, etc.) thrive on these lands, and among the conifers (pines, etc.) the long-leaf pine is the only one growing naturally on them.

The short-leaf pine, except where the loam subsoil lies near the surface, is rarely found, and it is only after the ground has been cultivated and enriched and the moister layers of earth have been brought to the surface that the loblolly pine will grow there. So it seems that the long-leaf pine is the only native tree of much value which flourishes on these barren, sandy lands. There are very few if any other forests in the eastern United States so peculiarly limited as to the variety of valuable tree growth as the long-leaf pine forests, particularly when it grows on the sand barrens; and there are no other forests which demand such care to obtain a regrowth of the original dominant species.

Many kinds of trees after having been lumbered or burnt out are succeeded by smaller and less valued species, but the original growth in time again takes possession of the land. This is the case with the spruce forests of Western North Carolina and the white cedar (juniper) in the eastern section of the State. However it may have been primarily in the long-leaf pine forests this is not the result under the present management of these pineries. After the removal of the pine the land quickly becomes waste land, and passes from a growth of sand black-jack to utter barrenness. Nowhere is there any general sign of either the long-leaf or any other pine again forming a prominent part of the growth on these sand-hills.

Unless there is some radical change in their management these lands may even cease to produce the few sand black-jack oaks which now flourish on them. There is even a possibility, and in fact it can be said a great likelihood, that this valuable tree, the long-leaf pine, will become extinct in North Carolina unless some steps are taken to secure its more general propagation. It has already become extinct over large tracts lying to the north of the Neuse river which were formerly occupied either exclusively by this pine or by mixed forests of it and hardwoods and the loblolly pine.

WHY LONG-LEAF PINE FORESTS ARE NOT SELF-PROPAGATING.

The causes which have operated to prevent the long-leaf pine from propagating itself are several, and all of them are important and act uniformly throughout this sandy area. A brief statement of some of the peculiarities of this tree may enable us to see more clearly why it needs more special protection than must necessarily be accorded other trees to enable the forests to reproduce themselves. The chief causes which have influenced and tended to retard the general regrowth of this tree at the present time arise from a highly specialized form of seed and plant structure and a decidedly unique manner of growth when compared with the other pines of this same region. These characteristic peculiarities lie chiefly in the young pine seedling, in the seed, and in the structure of the leaf buds.

THE SEEDING OF THE LONG-LEAF PINE.

Although the writer has not yet carried on systematic observations, on (1) the frequency of seeding of the long-leaf pine, (2) the relative abundance of its seed as compared with those of other pines, and (3) the relative fertility of boxed and unboxed trees of the same species, long enough to have obtained accurate results, yet the observations of different persons, thoroughly familiar, for many years, with the pines of the barrens, will, he thinks, for most of these cases, be found sufficiently accurate, their results being supplemented by his conclusions drawn from a personal investigation extending over several years. Although there were certain years in the primeval or virgin long-leaf pine forest, just as there are with all other trees, when no seed were borne, yet these years were rare and the yield of seed was usually abundant. William Byrd, writing in 1728, says* the mast of this tree (the long-leaf pine) is very much esteemed for fattening hogs, through all of Albemarle county (North-eastern North Carolina) on account of its greater abundance and the greater certainty of its occurrence (than that of the oaks). The forests of which he was speaking were largely virgin at that date. There are to be found frequent statements mentioning the same fact by other historians, of both an earlier and later date.

So far as could be ascertained the masts (as the seed of this pine are called) have not been as abundant for the past fifty years as they formerly were. There seems to have been only three large long-leaf pine masts since 1845. One of these occurred just about that time, the next one was in 1872 and there was one in 1892, which was not so large, however, as either of the preceding. There is a fairly abundant mast about every four or five years, and on intermediate years the production is small and localized. In North Carolina most of the trees which now bear seed are boxed and have been in this condition for from ten to fifty years. And the opinion prevails throughout the pine barrens that pine masts are less frequent and less abundant now than before the pines were so largely boxed and thinned out. The removal of a great portion of

*History of the Dividing Line between Virginia and North Carolina, p. 29.

the trees may explain, in part or wholly, why masts are less abundant. It would naturally be inferred that there would be a large decrease in the productiveness of boxed trees, whose vitality, measured by the rate of accretion between them and unboxed trees, has been greatly impaired by the practiced manner of boxing. However, from a tabulated record of observations carried on during several years there as yet appears no marked difference between the productiveness of boxed and unboxed trees, similarly situated.

There are several important differences between the reproductive capacities of the loblolly and long-leaf pines, all of them to the advantage of the former. The fertility of the long-leaf pine is much less than that of the loblolly pine, its most frequent associate. The loblolly pine bears cones at an earlier age, and usually produces more seed, both perfect and imperfect ones, and the great variety of soil on which the loblolly pines grow causes a slight difference in the time of flowering of different trees, making this pine less liable to have the entire prospect of a seed yield destroyed by frosts, or by heavy rains during pollination. While this may possibly explain why the loblolly pine has come up as a regrowth over so much of the moister loam land it has affected the growth of the pine barrens very little.

The seed of the long-leaf pine are very large, one-third to one-half an inch long, independent of the wing, while no other pine of this region has seed over one-fourth an inch long. But there is a much smaller proportion of abortive and otherwise imperfect seed in a long-leaf pine cone than in the cone of the loblolly pine. This would be decidedly to the advantage of the long-leaf pine in seeding old fields, etc., were its seed not too heavy to be carried far by the wind. They usually fall within fifty feet of the parent tree, while the light-winged seed of the loblolly have been known to scatter thickly over fields from trees more than a quarter of a mile distant; and single seed are reported to have been blown several miles. And furthermore, as described more fully beyond, the seed of the long-leaf pine are much more extensively destroyed by hogs, fowls, squirrels, rats, etc.

Another reason for the exclusively loblolly growth in fields may

be that even when the seed of the two pines fall on the same land the loblolly pine by its rapid growth during the first few years overshadows and effectually crowds out the more slowly growing long-leaf pine, and the latter during this early slow growth are easily destroyed by fires and by live stock. The two are, however, rarely seen associated together in second growth woods. The seed ripening in October fall to the ground rapidly and if there is a warm moist season sprout immediately. In the event of a long warm rain just after the seed are matured they will frequently sprout in the cones and the entire yield will be thus destroyed.

DESTRUCTION OF THE YOUNG PLANTS.

The young long-leaf pine seems to be especially adapted by the form of its root system for growing on a sandy soil. By the end of its first year's growth its root system, which has grown rapidly, consists of a large tap-root which extends 6 to 10 inches deep in the sand, and from the bottom of it branches out the smaller roots which draw nourishment from the soil. It is this deep-seated root system sent thus early far down into the soil which enables this pine to grow on the sand barrens, and it is doubtless because the roots of the loblolly are small and divide for the first year or two into a great many small divisions, lying near the surface, that it does not get sufficient moisture and nourishment from the dry surface sand to enable it to thrive on the sand barrens before this land has been cultivated. This long tap-root of the long-leaf pine frequently goes through the sand into the loam soil and secures for the tree a firm anchorage against storms and enables it to draw its nourishment from a more fertile soil.

The stem parts of the long-leaf pine are as peculiarly adapted for growing on a sand soil as the root system is. Instead of the stem's branching or growing the first year it only puts out a great number of very long thick leaves, exceedingly close to the ground. These leaves soon spread out and help to shade the ground close to the plant and keep it moist. At the end of the first season's growth the single (terminal) bud is not over an inch and a half above the earth and the bud itself is nearly an inch long, so that it can be said that the stem of the seedling does not grow any in

height during the first year, all the energy of the plant being diverted to increasing the root and producing the great tuft of long deep green leaves which spread out immediately below the bud and make the plant resemble more a tuft of some marvelous kind of grass than a young tree. Some of the lowest leaves usually die during the first year; most of them remain on, however, for two seasons.

During the second and third years the growth of the stem in height is slight, though it increases in thickness, but after that, at least in a forest, its growth is wonderful. Frequently in a thick wood where a young tree has been allowed to grow, in 8 or 9 years after height-growth has begun, it will have reached a height of 18 or 20 feet and a diameter of no more than 3 or 4 inches, and will have grown each year from only one bud, the terminal bud, at the end of the woody axis, there being no branches, and no sign of any having been formed. For leaves there will be only a single, broom-like bunch terminating the slender stem. The rapidity with which this stem is raised and the fewness of its branches until the natural height of the tree is reached makes one of the fine qualities of the timber. It gives long stocks which have no knots in them, even small ones, to produce any ununiformity of quality, or to make weak places on the interior of an apparently perfect piece of timber.

This feature which is the cause of so fine a quality of wood is a great drawback to the development of the young trees. This single terminal bud is a very large and complicated structure, and when once destroyed in any way no other bud is usually formed by which the growth of the young seedling can be continued. It is true of most conifers (*i. e.*, pines, firs, cypress and cedars) that they do not readily form buds and that they rarely sprout from the stump and are very difficult to reproduce from cuttings, etc., but with the long-leaf pine such buds are formed and sprouts developed even more rarely than with most other conifers.

THE ENEMIES OF THE LONG-LEAF PINE.

The long-leaf pine has a severer struggle for existence than any other of our forest trees for the reason that in all stages of its

reproduction and growth it is more severely and continuously attacked by a greater variety of enemies than any other. Besides the natural drawbacks to its development from the peculiar manner of forming several of its parts, and the fact that these parts when destroyed are not replaced, its large and sweet seed are eaten in large quantities by *fowl* of various kinds, *rats*, *squirrels*, and by *swine*, which prefer them to all other kinds of mast and, when there is enough long-leaf pine mast, become very fat on it.

As far as has been observed, young long-leaf pines are attacked by no injurious beetles or bark-borers or by any fungi sufficiently to injure them. The mature pines, however, have in past years several times been attacked by bark beetles in such numbers as to destroy the pine over large areas. A few trees which have been killed from their attacks can be seen at any time around the edges of districts where lumbering is in progress, or about districts which have been recently lumbered.

DESTRUCTIVE WORK BY HOGS AND FIRES.

If the destruction by swine ceased with eating mast there would still be sufficient seed left to reproduce some parts of the forests, as the mature trees are gradually thinned out, for one-year-old seedlings are common twelve months after a heavy mast. No sooner, however, has the young pine gotten a foot high and its root an inch in diameter than the hog attacks it, this time eating the roots, which, until two inches in diameter, are very tender, juicy, pleasantly flavored and free of resinous matter. In the loose sandy soil the piney woods hog, or "rooter," finds little difficulty in following and devouring these tender roots to their smallest ends. Many small trees are destroyed in this way. And cattle, furthermore, are said to bite off frequently the tops of the small plants, and with them the terminal buds, in the early spring. This is doubtless done while grazing, more accidentally than otherwise.

Fires often destroy all the young pines that escape the hogs. They kill the small pines by burning the highly inflammable bracts around the bud and so stop its growth, or in high grass frequently burn all the leaves. Larger trees, even until they are 3 or 4 inches through, are easily killed in spring, when the sap is

rising and the outer layer of wood is growing rapidly, by a hot fire which will burn the thin exfoliated layers of bark all over the trunk. The loblolly pine is less injured by fire because its bark is thicker and so offers more protection to the growing wood; the bark, too, lying closer to the wood in firmly appressed layers, does not so easily take fire. (See, also, the discussion on page 61).

The chief agencies, then, which prevent a regrowth of the long-leaf pine on the high sandy lands are the hogs and the fires; and the attacks of the hogs are directed against parts which seem to have been developed to meet requirements of a plant growing on a dry, barren soil of loose sand. These peculiarly developed parts are the seed, large for a pine, which contain abundant nutriment for the young plant to enable the root to push itself rapidly into the sand; and the long, succulent root which grows for a considerable distance straight down without branching. Since the first settlement of these sandy lands the "ranging" of swine has been allowed in the barrens, and while there were enough pines standing and frequent masts, they fed a large number of hogs.

The practice of firing the barrens has been adopted in many cases with a view to improving the pasturage; while in many other cases, after the trees were boxed, the leaves and trash pulled away from around them, the forests were burned over to prevent in a dry season a chance conflagration getting from under control and burning the faces of the turpentine boxes and the timber. That this policy of burning the barrens is a very bad one and calculated to do far greater damage than that immediately apparent has perhaps been made evident. The accompanying illustration (Plate I) shows one of these long-leaf pine forests, near Southern Pines, where a recent fire destroyed all of the young growth, the turpentine boxes and most of the timber trees.

That sooner or later the present management, or lack of management, which has characterized all dealings with the barrens for the past 150 years must be changed if the long-leaf pine forests are to be made self-propagating, no one who has ever seen their condition or fully realizes what it is can possibly doubt. The logical result of these burnings in the past has been the destruction of millions of feet of standing pine and the prevention of the growth of young trees, which, had they started even fifty years ago would



LONG-LEAF PINE FOREST A FEW MONTHS AFTER THE FIRE; MOORE COUNTY.

now be large enough for small mill timber and for turpentine; while the burnings of the present and future, if not soon discontinued, will mean the final extinction of the long-leaf pine in this State.

THE ULTIMATE UTILITY OF THESE WASTE LANDS.

It has been practically demonstrated, in the vicinity of Southern Pines and elsewhere, that, after having been richly fertilized, considerable portions of these sandy pine-barren lands, containing a small portion of loam and organic matter mixed with the sand, are adapted, by their southern situation and light, friable soil, to a high state of productiveness in fruits and vegetables; and these branches of agriculture are rapidly increasing in North Carolina. They appear to be more especially suited for vinticulture and gardening. It is probable, however, that large portions of these waste lands will not be brought into cultivation during the next fifty years, nor at any time, owing to the extreme poverty of the soil. What then is to be done with this 400,000 acres, once covered with long-leaf pine, but now of little more value than a similar area of a genuine desert? If the present lack of policy in regard to their management is continued, it is only a matter of a few years before the long-leaf pine which is now standing on the sand-hills will also have been destroyed without giving profitable returns to its owners or leaving behind it a young growth of pine to take its place. It becomes manifest at once that if the scattering trees, which might serve as seed trees, are entirely removed from this waste land, it will not only be a very difficult but a very costly matter to secure a regrowth of long-leaf pine or any other valuable building tree, either pine or hardwood.

No matter what is the ultimate use to which the land may be put there must necessarily be, on a considerable part of it, trees which grow large enough to furnish timber and fuel more abundantly than the black-jack oak can do. A pine alone can supply such wants when there is only an impoverished soil to grow on, and the long-leaf pine can do this better than any other pine.

No community, least of all one devoted to agriculture, no matter whether it raises cotton, garden truck or fruit, can be independent while at the same time it is dependent on some other sec-

tion for either fuel or building material. This, however, is what some sections of eastern North Carolina are fast coming to, and the fact is being recognized by not a few of their most thoughtful residents.

That the existence of a highly developed agriculture is sometimes entirely dependent on a forest is shown by the condition of the lands between Bordeaux and the coast of France along the bay of Biscay. This district is the seat of the manufacture of the Bordelais wines, clarets and other light wines, and some of the finest wines are made in vineyards east of the Médoc from vines grown on a highly sandy soil. A great part of this land is covered with forests of pines, which were set out, at great expense, to prevent the shifting of these sandy soils. Before the planting of the forests these lands were sand dunes, or heather lands which formed dunes of moving sand as rapidly as the low, scattered heath growth was removed.

In view of the facts stated in the preceding pages we are driven to the conclusion that the most practicable plan of treatment of these waste lands, with a view of making them again productive of wealth to their owners, is that of protecting these areas against the attacks of hogs and forest fires and thus permitting them to be again covered with a new growth of long-leaf pine.

COST OF SECURING A NEW FOREST GROWTH.

The cost of securing a regrowth of long-leaf pine on most of this waste land would now be very little in addition to what the land-owners must necessarily pay to retain their land which has ceased to be productive or give any returns. Interest on the capital invested in the land probably has to be paid and taxes must be paid yearly. The additional cost would be solely that arising from protecting the land from fire and from excluding cattle and swine for a certain number of years after a mast.

The opposition such a measure would produce would be considerable, especially among a class of indigent citizens who, owning little or no land themselves, have always been accustomed to give their cattle free range over the lands of others, to fire the dead grass for bettering the pasturage, and even to cut timber for home

use on these lands *ad libitum*. It is the opposition of these people, who constitute so large a part of the voters, that has prevented in several of these eastern counties the adoption of a general law for confining cattle and stock. As timber for fencing material and other purposes becomes scarcer, the more intelligent citizens are coming to see clearly enough the imperative need of such a change, both in our laws and in public opinion, as will suffice to protect the young forest growth from fires and stock, and thus to give the valuable forest trees an opportunity to propagate themselves.

NECESSARY PROTECTION OF YOUNG PINES AGAINST FIRES AND HOGS.

Without a thorough cessation of fires and an equally thorough exclusion of stock, at least until the trees are thickly started and well grown, say until 10 feet high, any effort to produce a uniform growth would be futile. Once that a new growth has secured a firm foothold and has formed a dense covering, the very thickness of it, by its exclusion of most low growth and grass, will be preventive of fires, since the thin covering of pine straw and humus will not carry fire except in very dry seasons or before a heavy wind. The exclusion of swine is a measure which must be absolutely enforced until the trees have reached a diameter of 3 or 4 inches. (See, also, page 57).

The following statements will show what an important part fires play in the destruction of pine seedlings:

In the fall of 1892 there was a very full long-leaf pine mast, and in the following spring seedlings could be seen by thousands. In moderately dense long-leaf pine forests in Montgomery county, where there was about one-half as many of those pines standing as when it was in a virgin state, these pines being mixed with a few post and black-jack oaks and the rest of the land open, there were from 15 seedlings to the square yard in the open to 35 seedlings on an equal area beneath some of the trees. A space which was staked off and noted was examined again in the fall after a fire had passed over it and then it did not average one seedling to the square yard. The soil here was a salmon-colored loam and the grass largely broom-straw (*Andropogon Virginicus*).

Another tract, which was on the sand-hills of the western section

of Cumberland county, was examined shortly after it had been lumbered. This was not seen in the spring, but when visited in the fall showed by the great number and position of the cones that seed must have fallen abundantly over most of the ground which had since been burnt over. It was hard to find, however, a seedling which had escaped the flames.

Another place examined was in Bladen county, on a sandy loam soil. There were in the spring of 1893 numerous seedling pines there. A later examination in the fall showed a large number still growing, but no fire had passed over them and the roots were not yet large enough for the hogs to root up. A small portion of this last tract has been fenced off and the progress of the seedlings in the enclosure, and those outside, will be compared and the requirements and peculiarities of the young plants studied as they develop.

If it had been possible, immediately after the falling of this mast of 1892, to put the long-leaf pine lands, or at least those parts which are most sandy, and have only a thin cover of pines, or the large areas recently lumbered, under some management which would have given protection to the seed and later to the young pines, in ten years with continued protection there would have been over the larger part of this area a thicket of pines large enough to have been self-protecting in a great measure, and in a fair way to become trees suitable for lumber and for yielding supplies of turpentine.

At the date of this writing it is a safe statement to make that there have been already destroyed over nine-tenths of the pines which sprung up so abundantly less than two years ago. The time which will elapse before another large mast is of course uncertain. Smaller masts should occur, however, in three or four years. Last year (1893) there was none. An examination of the pines shows that there will be very little this fall. The freeze in April of this year (1894) destroyed the pollen of the trees along the western part of the pine belt, but as they have not been examined further east it is uncertain whether it was destroyed there also.

There will consequently be little pine mast in 1895, at least in

the western parts of the long-leaf pine belt, as it requires two seasons for growth and maturity after pollination has taken place.

FOREST MANAGEMENT IN THE WASTE-LAND REGIONS.

Just here, in connection with the discussion as to what policy should be adopted in regard to the treatment of the pine barrens, a brief statement of what forestry is and what it necessarily is not, will not be out of place. The two conceptions as to what forestry is are in part equally erroneous. One of these is that forest management consists in protecting trees with no definite end in view beyond that of protection. The other conception contains a half truth. It is that forest management consists in the production of trees and the systematic management of timbered lands, but that the State or government's ownership of such timbered lands is essential for putting this into practice. This latter view of the matter is fairly correct except that ownership or management by the State or government is by no means an essential feature. In a country such as ours timber lands must be managed by their owners or not at all.

From the point of view of a money-yielding investment, and this is the chief view that need be considered in dealing with most of the lands of eastern North Carolina, the following might stand for a definition of forestry: Forestry consists in the systematic care of forests so that the land will always yield valuable forest trees and so that production of timber may be carried to its highest possible limits. This growth of course is to be utilized, *but in such a manner that a young growth of equal value to the one removed may take its place.* Such management is not only not inconsistent with private ownership of land, but if properly carried out by private parties can be made more efficacious, at least as far as financial results are concerned, than when carried on by a government or State.

It is true that in some European countries much of the forest is owned by the various governments, municipalities, etc., but much of this land was owned by the respective governments for many years before any forest management was practiced. Their owner-

ship by the governments was not at all necessary for the practice of forestry in these countries, and there is more forest land under systematic management in Europe owned by private parties than by the governments.

In some of the private forests, as those of the Tyrol, cuttings are restricted and are superintended by trained government foresters, because from the situation of the lands in hilly or mountainous districts the sudden removal of all timber from over a large area might cause the land to wash, so that reforestation could only be accomplished under serious difficulties. The clearing of large areas and their remaining in a state of denudation causes in hilly countries, where the soil washes easily, great floods in the rivers which are filled with *detritus* washed down from the hills. Such floods endanger the life and property along the streams, while the deposit of the soil washed down seriously affects arable lands and the channels of the streams. The control of such lands as these is not undertaken by the governments with a view of influencing in any way the owners' profit, but as a measure to protect other citizens whose interests might be much affected by any carelessness or greed of a timber owner.

In Germany, which country probably leads the world in the thoroughness of its forest management, there are about 43,000 square miles of forest.* The government owns about 13,300 square miles of it, various local organizations, towns and small principalities own 6,700 square miles, while the rest, about 21,700 square miles, belongs to individuals, and its management is entirely free from all governmental interference, except so far as the cutting of one person's timber will damage lands or property belonging to another, in which case an injunction to prevent cutting can be obtained from the courts.

THE NECESSITY FOR FORESTS IN THE FUTURE.

The question is asked, Will there be any use, fifty years from now, for a forest grown on this waste land when so large a part of the State and country will be timbered by a second growth of pines

*Paul Pary's Yahrbuch, 1890. Landwirtschaftliche Statistik, 1889.

and hardwoods which have naturally sprung up? Moreover, it may be thought that in that length of time a large part of the original forest growth will still remain uncut.

An examination of the facts in the case will yield an answer. Ten years ago it was thought that the supply of white pine was inexhaustible in Michigan, which State then had far the largest bodies of pine, and in fact nearly all the merchantable white pine in the United States except that in Wisconsin, Minnesota and some in West Virginia. Bulletin No. 5 of the Eleventh U. S. Census showed that in 1890 Michigan had an output of white pine of about 10,000,000,000 feet, board measure (including shingles), and that there was supposed to be only enough timber standing to last the mills for five years longer. Many persons even then ridiculed the idea of the exhaustion of the white pine. A few months ago the *Northwestern Lumberman*, which had most loudly proclaimed that the white pine was inexhaustible, announced that this season there would be in one district a shortage amounting to many million feet, and that the total shortage in Michigan alone would probably amount to over a billion feet, board measure. Other soft woods, yellow poplar, etc., will probably be sawn to take its place for several years, and will come from Kentucky, Tennessee, North Carolina and other regions in the Appalachian mountains.

In ten years from now the forests of Michigan will have been a thing of the past, so that within fifty years after lumbering began on a commercial scale the white pine and probably the best hardwoods will have been cut out. These forests of Michigan cut from two to three times as much mixed hardwood and pine to the acre as the pine lands of eastern North Carolina will now yield, after having been picked over for two hundred years.

The forests of Washington are as yet in a nearly virgin condition and are probably the finest in the world. They will cut three times as much to the acre as the pine lands of eastern North Carolina, and although the amount of standing timber was estimated on January 1, 1894, to be near 400,000,000,000 feet, board measure, yet such is the enormous destruction of timber by fire and the rapid increase in the milling industry, which now cuts only 1,000,000,000 feet a year in that State, that those forests will probably not last longer than fifty years.

The forests of all the Northern States have been cut over and the most valuable timber removed. Maine, Vermont, western Pennsylvania and West Virginia still manufacture, however, large quantities of hardwoods, but the supply of them is so rapidly being reduced that in a few years the annual output will be reduced to the growth in the forests during a year.

The condition of the timbered lands is about the same in all the Southern States. The pine in the lower districts has in places been entirely removed, but in other places there is still much left, while the hardwood on the uplands has for a century been called upon to supply local needs and in most places has had the finest timber culled, except toward the mountains of the south-eastern States where there are magnificent virgin forests of hardwoods. These forests of the South are the ones to which the lumbermen of the North are looking as the supply of timber near the seats of consumption becomes exhausted, and once that the tide of millmen turns this way the depletion of the forests of this State and those farther south will be a matter of only a few years.

Bulletin No. 5 of the Eleventh U. S. Census gives the amount of yellow pine and cypress land owned in nine Southern States by establishments located only in Michigan and Wisconsin to be 1,407,358 acres, estimated to have standing on them a total product of eleven billion feet, board measure, of merchantable timber, valued at $8,723,000. The timber on this land is cypress and hard pines—*i. e.*, long-leaf, loblolly, and short-leaf pines, and this large amount invested shows that Michigan millmen, already foreseeing the exhaustion of the northern forests, are investing in those timbers which are suitable to take the place of the white pine. Even at the present rate of removal, and allowing that there is no decrease in the business from the free entrance into the United States of Canadian lumber, the standing pine in the eastern part of North Carolina cannot last twenty years, and may not last more than fifteen years, unless a wise policy obtains. The indications are, however, that there will be in the next five years a much greater expansion of the milling industry in eastern North Carolina than has taken place during the past five years and a pro-

portionally greater increase in the annual output of lumber, and decrease in the available supply of standing timber.

WILL A REGROWTH OF PINES ON THESE WASTE LANDS PAY?

This question has been asked; and it is the first point to be considered in connection with any attempt to restock these waste lands with long-leaf pine. And in answering this question we may ask another: Will it pay to let these lands lie idle and unproductive? The cost of securing a growth of pines on these lands will be the cost of keeping off the hogs and fires, and this will be but little if any more than what proprietors have to pay at present for the privilege of holding these unproductive tracts. If it pays to own these lands unoccupied and unproductive, it will pay much better to own them if they are restocked, at a slight cost, with long-leaf pines.

One of the chief considerations upon which the final value of a regrowth of long-leaf pine depends is the securing, in as short a time as possible, a thick, homogeneous growth of young trees, and the entire prevention of all fires among the pines. Nowhere else is the truth of the strength of unity more exemplified than in a forest growth, especially in a young and growing forest, on an arid and impoverished soil, where one of the necessities is retaining the moisture in the earth and preserving the humus formed by the decay of leaves. This moisture will serve to supply the trees with water essential for their development and tend to check or even prevent fires. The damage fires do to a forest growth, even after the growth is well started, is considerable and has much influence on the character of the timber. By killing a part of the timber they make the growth open and the stocks short-bodied and filled with limbs and resulting knots. The thicker the growth the taller and straighter will the stocks be, and so much greater and more valuable will be the *final* yield of timber.

RATE OF GROWTH OF LONG-LEAF PINES.

After a large number of measurements of young growth trees, which have sprung up in enclosures, or where protected, it has

been ascertained that it will require from thirty-five to fifty years for such a growth to reach sufficient size to furnish saw logs 20 feet long and from 14 to 20 inches in diameter. The usefulness of these trees will have begun, however, in less than half of that time, since their increase in size is much more rapid during the earlier years of growth than during the later years. After twenty-five years they will be large enough to hold a turpentine box. About this age, too, they begin to bear mast, and as the foliage becomes more open the more tender grasses of the barrens appear and afford pasturage. Besides this there is a great quantity of litter which yearly accumulates under the trees and can be used, as such litter now is, when it can be gotten, as a mulch for agricultural lands. Moreover, the lands themselves will have gained a permanent improvement from the mould which will have accumulated on the ground during the time that the trees were growing.

FUTURE VALUE OF TURPENTINE ORCHARDS.

What may be the value of turpentine orchards twenty years hence is of course a speculative question. With the great variety of uses to which both rosin and turpentine are put it is hardly likely that in that time any cheaper substitute will be found for them in all their uses.* The area of long-leaf pine which will be under orchard at that date is also largely a matter of conjecture. The observations of the writer and of several specialists who have examined all or parts of the territory covered by the long-leaf pine, would lead to the conclusion that, without some radical change in the manner of boxing, and the reservation by timber owners of large tracts of pine for turpentine culture only, the orchards of the United States, with the possible exception of

*USES OF RESINOUS PRODUCTS.—In a report upon the maritime pines made in 1878 by M. Desnoyers at the Universal Exposition of Paris the following uses are given for the different resinous products of that tree:

Spirits of turpentine is used in the manufacture of oil colors, varnishes and paints, in the preparation of rubber, is employed in medicine and veterinary arts, and for cleaning and illuminating and making water-proof putties and cements.

Rosin is used in sizing paper, in soap-making, in the manufacture of sealing-wax, for soldering lead and in tinning, and from it is obtained by destructive distillation rosin oil which is used in making lubricants, printing and lithographic inks, paints, etc., and painting beer-kegs Crude turpentine scrape and pitch are also used in many of these manufactures.

those of Texas, will have seen their best days in less than twenty years.

The Report of the U. S. Division of Forestry for 1891 describes the pine lands of eastern Texas and western Louisiana as follows:* In the center of the region above the Red river, pine ridges alternate with tracts of oak and hickory. Toward the Red river the forests covering the undulating pine lands remain practically unbroken to the Sabine river. On the east side of the Red river the area is estimated at 1,625,000 acres, extending northward an average distance of fifty-five miles, cutting from 4,000 to 6,000 feet to the acre, with no change in character to Trinity river in Texas. In that State the forests of long-leaf pine cover about 5,000 square miles, merging toward the north into the region of short-leaf, toward the south into vast forests of loblolly pine. The fact that but little tapping for turpentine has been practiced in this region may be of importance from a market point of view.

Forests suitable for the manufacture of turpentine, being subject to a triple destruction, will probably give out some time before those suitable for lumber will. Turpentine orchards of long-leaf pine are destroyed by being lumbered, by natural exhaustion from continued tapping and by fires; and their trunks being weakened by boxes the trees are more liable to blow over by the winds. They are renewed only to an inconsiderable extent by regrowth. The rate of destruction by each of these agencies has been yearly increasing, and has not yet reached its maximum limit.

FUTURE VALUE OF LONG-LEAF PINE FORESTS.

The future value of a forest of long-leaf pine as a source of lumber is based on these facts. Long-leaf pine wood, even after it has been tapped for turpentine, which has no effect on any of the heart wood except to a slight extent those parts immediately in contact with the faces of the boxes, is much stronger than any other of our pines; and it is especially durable in contact with the soil or when exposed to alternating conditions of being wet or dry. As these qualities of the timber become recognized they will much increase

*Annual Report Secretary of Agriculture, 1891, p. 216.

the value and use of the wood for purposes where such qualities are requisite. The rapid thinning of the woodlands of the eastern United States will cause an increase each year in the value of all timber near centers of consumption; and there is a constant increase in the value of stumpage as the utilization of the forests proceeds. When once the mass of standing woody material, the uninterrupted accumulations of centuries, is destroyed, the entire country will each year be dependent for wood on what may be called the annual increase in the forests.

The lands of the greater part of the northeastern States are already in this condition, and those of the southern States, with the exception of the hardwood forests of the Appalachian mountains, are fast being reduced to a similar condition. This second growth forest is producing very largely nonvaluable woods, having been produced by the seed of inferior species left in lumbering as worthless, and only such of these survive as can naturally withstand the repeated burnings to which the woodlands are subjected. Moreover, most of this second growth is very open and thin, caused by fires and other agencies, and the trees from the same causes are often defective. A large part of the land which should be timber land is unproductive waste land, with absolutely no arborescent growth, and the continued violation of all natural laws concerning plant-life prevents the development of such a growth. The demand for wood is yearly increasing and each year the power of the woodlands to supply it is diminishing.

An abundant supply of wood and timber must be an important factor in the future development of eastern, and particularly south-eastern North Carolina, whether that development be an agricultural or manufacturing advancement; but unless there is a more strict observance of the fundamental laws of all plant-life, particularly in respect to the long-leaf pine on the high sandy land, preventing the destruction of the seed and young pines, this section will be in great want of timber at the time when it will need its timber most.

AREA OF WASTE LAND INCREASING.

In conclusion, it can be said that there are now 400,000 acres of waste sandy land in Eastern North Carolina, and that this area is

constantly increasing. This land is covered only with a low, scrubby growth of sand black-jack oaks and in places has mixed with these oaks scattered long-leaf pines, unfit for lumber and exhausted of turpentine by the continued tapping. Malpractice, especially the custom of firing the barrens and allowing stock full range on them, has never given the long-leaf pine an opportunity to reproduce itself except over very limited areas, and where protected. From this cause this pine, which will always have the highest value, both for its timber and the abundant resin which it contains, is in danger of becoming extinct in North Carolina, and indeed in all the States where it now grows, at least as far as its commercial importance is concerned.

IMPORTANCE OF EARLY ACTION.

If the long-leaf pine which is still standing is allowed to seed these lands, and the seed and young pines protected from destruction, a regrowth can be obtained with comparative ease, but if the long-leaf pines now standing are once destroyed, the securing on these waste lands of a growth of trees which will be of economic importance will be both a difficult and costly undertaking, since this pine is the only tree of value in the arts which naturally grows on these barren lands. It will cost very little more to secure a regrowth than it does to retain the lands in their present impoverished and unproductive state, since taxes and frequently the interest on the original investment must be paid.

The adoption of some general law for these districts, requiring stock, especially swine, to be confined, would be of great help in securing a regrowth, but it would be imperative, at the same time, to prevent any fire from passing through the barrens, since one fire can kill in a few hours a growth of pines several years old. The final value of the growth would depend, too, on fires being kept out even when most of the trees were large enough to be uninjured by burning. By the time such a growth reached maturity or became large enough to furnish timber, all the original forests will have been cut over and the usually thin and scattering regrowth will be called upon to furnish not only most of the fuel, but all lumber and timber required in building and manufacturing.

So great is the annihilation of the primitive forests and so rapidly does the demand for lumber increase from year to year that it is doubtful if the entire forests of the Southern States can last longer than two or three decades. The same is true of the pine forests which can be used for turpentine production. The ruin of these forests will cause a marked rise in the value of all forest products, so that a certain and a higher-priced market can be assured for all future forest material.

CHAPTER III.

THE NAVAL STORE INDUSTRY IN NORTH CAROLINA.

HISTORICAL SKETCH.

In Colonial Times.—As early as 1700 the production of naval stores was an industry of some importance in the Colony of Carolina. At the same time the industry was carried on in the adjacent parts of Virginia. In Virginia the products were largely derived from the loblolly pine, while in North Carolina they came chiefly from the long-leaf pine. The products exported from the colony at that date were tar and pitch and some crude turpentine; but the quantity of the latter shipped was small. Tar kilns were made then as now and the process of burning was the same. Indeed, the process is very much the same as that described by Theophrastus as being used by the ancient Greeks.

The *tar* manufactured in the Southern States was more commonly converted into *pitch* before being shipped, by the addition of some crude turpentine and the mixture then being boiled down to the right consistency. From north-eastern North Carolina it was shipped by way of Norfolk, Va., to England, the laws of England at that date forbidding colonial products from being shipped to other than English ports. Until about 1800 the making of tar was not as largely confined to North Carolina as it is at present, nor even to the Southern States. Besides being burnt in Virginia from the loblolly and short-leaf pines, some was made in New York and other Northern States from the pitch pine (*Pinus rigida*), but more for home use than for export. Georgia and South Carolina also produced considerable amounts in colonial days. The method of cutting the boxes for collecting the crude turpentine was then the same as now. The names of some of the parts connected with the process have slightly changed in the meantime. *Cornering* was then called *notching* and the *virgin dip* was called *pure dippings*. These names continued in general use until the early part of the present century.

Both the tar and the crude turpentine produced in the northeastern part of this State were marketed, in the early days, usually in exchange for goods, at Nansemond or Norfolk, Va., and there found ready sale. Before the beginning of the present century both commodities had practically ceased to be produced around Albemarle sound. The seat of the industry slowly moved westward from thence up the Roanoke and Tar rivers and southward, as the settlements extended, to Washington and Newbern, both points shipping large quantities of naval stores to New York and Philadelphia, where it was reshipped to England, and there the crude turpentine was distilled. The largest special use for the crude turpentine in the United States then was for mixing with fats, etc., in making yellow soap.

Later Developments.—Before 1800 Wilmington became one of the largest shipping points for both crude turpentine and tar. In 1804 the exportation of crude turpentine from Wilmington amounted to 77,000 barrels, and the total amount of naval stores shipped exceeded that from all other ports of the United States. The crude turpentine was brought down the rivers on rafts and small boats from as high as Edgecombe county to Washington, from Wayne county to Newbern, and from all the northern tributaries of the Cape Fear river to Wilmington, and was distilled in crude iron stills partly at the shipping points, partly in Philadelphia and New York, and much also went to England to be there distilled. The spirits of turpentine usually found quick sales and good prices except when overproduction took place, and was preferred in France even to the Bordeaux turpentine, which was made in the department of the Landes in Gascony, being less odorous and more uniform in quality than that. The rosin manufactured was worth very little, getting down as low as 25 cents a barrel and then so low it would not pay to handle it. The tar and pitch manufactured at first gave general satisfaction and were made in large quantities. In 1770 there were nearly 100,000 barrels of tar and pitch shipped from the United States, about one-fifth of this amount being pitch shipped from North Carolina.

In 1799 the tar used in England came in equal proportions from Russia, Sweden and the United States. Later the Carolina tar

and pitch were less esteemed in England, where they were said to burn the cordage more than the products made in the Baltic provinces. This was said to be due to dead wood being used in North Carolina for making tar and the burning being carried on so rapidly and at so high a temperature that wood acids were formed in large quantities along with the tar. American products were also objected to because they were earthy, the receptacle being carelessly made, and were packed in insecure, leaky barrels. These last objections are sometimes made against them now, though the use of cases for shipping has tended to remedy the evil.

In Bothnia and Sweden, on the other hand, only living wood of the fir and usually from the lower part of the trunk and roots were used and burning was carried on more slowly. In 1831 there were imported into England 10,900 lasts of tar, of 14 barrels each. Of these 8,700 came from Russian provinces on the gulf of Bothnia, 1,200 from Sweden and only 1,000 from the United States. The amount imported from the United States has remained at very near these figures ever since.

The total value of the resinous products shipped from the United States, however, increased from about $200,000 in 1800 to $567,000 in 1834, and to $700,000 in 1838. Most of the products shipped up to this time were from North Carolina, as previous to 1838 trees were not tapped for turpentine south of the Cape Fear river, it being a generally held opinion that south of that river the pines would not yield. This error was soon discovered by experimenting with the trees in that section and orchards there soon became as valuable as those farther north.

In 1836 copper distilleries were introduced in this country and at the same time there was an increased demand for spirits turpentine as a solvent of India rubber, this being the cheapest solvent of that article obtainable, and was thus used in the manufacture of rubber goods. It was also used for illuminating purposes, though the different forms of petroleum oils and the general use in towns of illuminating gas, made from coal, soon supplanted it. Stimulated by this increased demand the production of turpentine extended rapidly southward beyond the Cape Fear river into South Carolina, and up the Cape Fear to Cumberland and Har-

nett counties. The British free-trade measure in 1846 gave free entrance into English ports to the products manufactured from turpentine and this stimulated the manufacture of these products in North Carolina. From this date forward the exports of crude turpentine decreased as the exports of spirits turpentine, rosin, tar, etc., increased.

It was found more economical to move the stills as close to the seat of production as possible, so that when rosin was low in value the spirits of turpentine only need be shipped. This allowed work to be done farther from the water-courses, near to which the industry had been previously confined. By 1855 about one-half of the spirits of turpentine shipped from Wilmington was distilled inland. The shipments from Washington and Newbern had already begun to decline, the building of the Wilmington and Weldon Railroad having largely turned their trade toward Petersburg and Wilmington.

By 1860 the orchards from which Washington drew its supply approached exhaustion and production soon ceased. Newbern being farther south, the industry continued there for several years longer, but after 1870 the decline in production became rapid and practically ceased during the past decade. There is now no distillery in full operation within thirty miles of Newbern. North of the Neuse river there were in 1893 only eight distilleries in operation, with an output for that year of less than 7,000 barrels of rosin. Three of these distilleries were in Johnston, two in Nash, two in Wilson and one in Wayne county.

South-westward Extension of the Industry.—After 1835 the seat of the production of turpentine began to move southwestward through the Southern States. In 1840 the value of the total product amounted to $593,451, nearly the entire amount being produced in North Carolina; and in 1860, while the value of the total product in the United States was $7,454,000, that of North Carolina was $5,355,778. In 1870 North Carolina, with 147 establishments, manufactured naval store products valued at only $2,338,000, while the total product of the United States, with 227 establishments, amounted in value to $3,585,000. In 1893 Georgia made about the same amount of turpentine and rosin

that North Carolina did, while Florida, Alabama, Mississippi and Louisiana altogether made about as much more.

The industry has only become of importance in Mississippi and Louisiana during the past few years, and is still capable of great expansion in these States. The turpentine orchards of Georgia are in about the same condition as those in this State, although there is probably in Georgia more round timber standing. The same may be said concerning the forests in Alabama. There are in Texas, however, between 3,000,000 and 4,000,000 acres of untapped long-leaf pine forests and the turpentine industry there has hardly more than made a beginning.

Inland Extension in North Carolina.—The first turpentine distillery at Fayetteville was established in 1844 by Thomas Lutterlow. The same year the first boxes were cut in what is now Harnett county, near Manchester, by Henry Harrison, who shipped the turpentine from there to Fayetteville to be manufactured. Ten years later there was a distillery owned by Jonathan Worth & Son in operation in the extreme western part of Harnett county near Buffaloe Springs.

The building in 1850 of a plank road from High Point to Fayetteville, which road was followed in a few years by a similar one from Fayetteville through the western section of Cumberland county and another which was projected to Raleigh through Harnett and Wake counties, but only partially finished, caused Fayetteville to become the seat of a large business both in handling turpentine and rosin and in distilling the crude turpentine. The satisfactory prices obtained, and the facility with which the produce could be gotten to Fayetteville on the plank roads for shipment down the Cape Fear river to Wilmington, led to the industry's extending before the outbreak of the civil war, even to the very western limits of the pine belt in Chatham, Wake and Moore counties.

The completion, subsequently, of railroads across the western part of the long-leaf pine belt caused a great deal of the rosin and spirits, manufactured along their lines, to be shipped direct to Northern and other inland consumers, without going *via* Wilmington. In 1893 over 5,000 barrels of rosin went direct west by way

of Paint Rock, and over one-half as much went direct north or to Norfolk by rail, as was shipped by way of Wilmington. Although the output of rosin and spirits of turpentine has more than doubled in the United States since 1860, the demand has increased nearly as rapidly until within the last few years, when there has been overproduction and consequently low prices.

VALUE OF THE NAVAL STORE PRODUCTS OF THE UNITED STATES.

From the Eleventh Census the total value of the naval stores manufactured in the United States for the year ending May 31, 1890, was $8,077,379. The product that year consisted of 346,524 barrels of spirits of turpentine, 1,429,154 barrels of rosin, and about 40,000 barrels of tar, pitch and miscellaneous products. The turpentine products given above represent the entire amount produced in the world for commercial purposes with the exception of that made in southern France and Austria, which altogether did not amount to 25,000,000 pounds (about 100,000 barrels).

AMOUNT OF CAPITAL AND LABOR EMPLOYED.

The cost of the crude material used to produce the output of naval store products in the United States in 1890 was $2,506,440, and the capital directly invested in the manufacture of naval stores in the United States was reported by the Eleventh Census to be $1,117,265, and in North Carolina $269,341. This capital, representing 670 establishments, employed 15,313 laborers in the United States and 1,747 laborers, on an average, in North Carolina, where there were reported to be 194 establishments.

The relatively small number of laborers given as employed in this State is due to the fact that the greater part of the turpentine is collected by farmers (or their "hands") who have a small area of turpentine orchard and utilize their time at dull seasons in this way; and many of these are not included in the above estimate. But some of the turpentine collected in other States is also gotten in the same manner.

CONDITION OF THE NAVAL STORE INDUSTRY IN NORTH CAROLINA.

During the latter part of 1893 the Geological Survey made an examination into the condition of the naval store industry in North

Carolina, and particularly into the condition of the turpentine orchards and the prospects of this industry in the State. The statistics for 1893 relating to this industry, which are given below, have been secured by correspondence with naval store dealers and distillers in all parts of the long-leaf pine region and by personal visits to many sections. The figures used in comparisons have been derived from the latest U. S. Census reports, unless credited to other sources.

SPIRITS TURPENTINE AND ROSIN STATISTICS.

The accompanying table shows for the year ending December 31, 1893, the number of turpentine distilleries in operation during the year, and the amounts of rosin and turpentine manufactured in each county, together with the amounts shipped from each county to Wilmington, N. C., and the amounts shipped direct by rail routes to consumers and dealers elsewhere.

Yield of Rosin and Spirits Turpentine in North Carolina, 1893.

County.	Number of Distilleries.	Rosin Manufactured.			Spirits of Turpentine Manufactured.		
		Barrels shipped to Wilmington.	Barrels shipped by rail elsewhere.	Total number of barrels.	Casks shipped to Wilmington.	Casks ship'd by rail elsewhere.	Total Number of casks.
Bladen	27	39,800	3,600	43,400	7,500	990	8,490
Brunswick	8	12,000	.....	12,000	2,800	.....	2,800
Columbus	26	37,200	.....	37,200	7,750	.....	7,750
Cumberland	24	21,000	15,000	36,000	3,200	3,961	7,161
Duplin	5	7,800	.....	7,800	1,060	.....	1,060
Harnett	9	3,700	9,050	12,750	400	2,335	2,735
Johnston	10	.....	16,764	16,764	.....	2,632	2,632
Montgomery	12	.....	22,000	22,000	.....	5,150	5,150
Moore	34	3,125	38,207	41,332	200	8,637	8,837
Onslow	12	12,600	2,700	15,300	2,700	450	3,150
Pender	8	10,400	.....	10,400	2,060	.....	2,060
Richmond	13	7,170	6,017	13,187	1,800	1,083	2,883
Robeson	28	30,200	9,910	40,110	4,712	3,233	7,945
Sampson	30	41,000	3,000	44,000	7,920	2,121	10,041
Wayne	3	.....	3,970	3,970	.....	517	517
*Other counties	7	4,000	7,768	11,768	800	1,517	2,317
Totals	256	229,995	137,986	367,981	42,902	32,626	75,528

*This includes four counties: Nash with 2 distilleries, Wilson with 2, Lenoir with 2 and New Hanover with 1. The amounts included in this statement for New Hanover county are estimates obtained by adding the average yearly output of one distillery.

The number of counties which produced crude turpentine during the year (1893) was 19. The amounts produced in New Hanover, Nash and Wilson were very small, New Hanover producing practically none. The greater part of the crude turpentine which was manufactured in that county was brought from South Carolina, and from inland counties along the Cape Fear and Northeast Cape Fear rivers.

The total amounts of rosin and spirits of turpentine manufactured in North Carolina and their values are shown in the accompanying table for the year 1893 and the census years ending May 31, 1870, 1880 and 1890 as reported by the United States Census for those years.

Quantity and Value of Rosin and Spirits Turpentine Manufactured in North Carolina.

Year.	Number of establishments.	Rosin.		Spirits of Turpentine.		Total value.
		Barrels.	Value.	Casks.	Value.	
1870	147	.....	.....	.....	.....	$2,338,309
1880	184	.....	.....	.....	.....	1,758,488
1890	194	365,233	$377,310	72,888	$1,293,086	1,705,833
1893	247	367,981	392,000	75,528	1,283,760	1,752,760

The total values represent the value of all products manufactured directly from turpentine.

Production has ceased during the past ten years in Wake, Craven and Edgecombe counties. There has been an increase since 1880 only in Moore and Montgomery counties, the number of barrels of rosin produced in Moore county for the year (1893) being considerably larger than the number produced in 1880, though the value of the product is less now than at that date. Montgomery county is credited with no resinous products in the census of 1880, but in 1893 there were 12 distilleries operating there which produced 22,000 barrels of rosin.

DECREASE IN THE PRODUCTION OF CRUDE TURPENTINE.

The quantity of crude turpentine shipped is small now compared with past shipments. All that was shipped last year went direct to domestic consumers, mostly manufacturers of printing

and lithographic inks. Boston was the largest market, New York and Baltimore being next in order. There were 6,331 barrels shipped from Wilmington and 4,600 barrels from other points, making a total of 10,931 barrels, with an estimated valuation of $12,000. The grades of this crude turpentine were not obtainable.

The general decrease in the amount of crude turpentine produced in the extreme eastern counties during the past twenty years is approximately shown by the decrease in the exports of rosin and spirits turpentine from Wilmington. This will not apply to the more westerly counties and to Harnett, Johnston, Cumberland and Robeson, since additional railroad facilities during the past ten years have turned a large part of their products from Wilmington. In a few of these counties, as in Montgomery and Moore, the product has increased considerably of late, owing to better railroad facilities, but this product is largely transported direct to Northern markets and does not enter into this statement of exports from Wilmington.

The total exports of rosin and spirits of turpentine from Wilmington for every year since 1872, as shown by the records of the Wilmington Produce Exchange, were as follows:

Total Rosin and Spirits Turpentine Exported from Wilmington, 1873–'93.

Year	Exports of Rosin, Barrels.	Exports of Spirits of Turpentine, Casks.	Year.	Exports of Rosin, Barrels.	Exports of Spirits of Turpentine, Casks.
1873	690,151	131,236	1884	342,936	71,354
1874	556,182	125,837	1885	314,724	66,603
1875	523,330	107,420	1886	331,497	63,684
1876	490,555	91,592	1887	381,535	71,912
1877	537,704	101,832	1888	246,566	63,473
1878	581,958	118,176	1889	351,827	61,626
1879	512,891	91,224	1890	385,523	70,285
1880	447,750	101,725	1891	304,818	60,844
1881	486,138	87,658	1892	273,291	58,034
1882	444,318	87,896	1893	224,070	47,228
1883	453,465	82,135			

When the exports of 1883, for both rosin and spirits of turpentine, are compared with those of 1873 there is shown a falling off of over one-third, while there is a falling off of nearly one-half in the decade between 1883 and 1893.

Many distilleries in the extreme eastern counties reported that their territory had not been thoroughly worked, during the last few years, on account of the low prices, and that any rise in prices would largely increase production. This fact may in part account for the more rapid decline in the receipts of rosin and spirits of turpentine at Wilmington since 1883.

The following table gives the foreign exports of rosin and spirits of turpentine from Wilmington and their value for the past ten years. The data were kindly compiled from the records of the custom-house at Wilmington, for the Survey, by Mr. J. M. Cronly, Deputy Collector of that port:

Quantity and Value of Foreign Exports of Rosin and Spirits Turpentine from Wilmington, N. C., 1874 and 1884–'93.

Year.	Foreign Exports of Rosin.		Foreign Exports Spirits Turpentine.	
	Barrels.	Value	Gallons.	Value.
1874	248,424	$.....	2,530,000	$.....
1884	300,932	405,776	1,418,848	470,644
1885	290,165	348,849	2,375,482	689,964
1886	288,499	306,538	2,139,091	732,642
1887	333,119	338,356	2,203,457	757,398
1888	311,613	341,825	1,988,103	695,476
1889	281,251	296,987	1,630,795	641,025
1890	302,094	394,569	1,751,270	709,988
1891	296,918	426,007	1,473,157	565,834
1892	251,853	271,394	1,080,231	372,534
1893	231,056	299,286	918,727	256,178

While the foreign exports of rosin have varied but little there has been a steady decline in the amount of spirits of turpentine shipped.

THE ROSIN TRADE.

The bulk of the rosin made in the United States is used in foreign countries, England importing the larger part of it. About two-thirds of the amount manufactured in North Carolina last year went to Europe, and the remainder to domestic consumers. Domestic manufacturers use more of the fine grades of rosin made in this State than foreign manufacturers do. An attempt was made to ascertain the amounts of the different grades of rosin manufactured,

but returns as to this point were frequently imperfect. There were, however, about 4,800 barrels of W. W. and W. G. rosin (the two highest and lightest colored grades)* shipped by rail from the western counties of the pine belt, and about 4,000 barrels of the same grades were shipped to Wilmington, from the more eastern counties of the pine belt. There were about 20,000 barrels of other grades of light rosin (above N.) made in the western counties, and shipped by rail, and about 25,000 barrels of these grades made in the more eastern counties and shipped *via* Wilmington. It seems that, while Wilmington handled nearly two-thirds of the rosin manufactured in North Carolina it only received about one-half of the finer grades of rosin. Practically all of the finer grades of rosin which were received at Wilmington, during the year 1893, were sent to Europe.

EXPORTS OF TAR AND PITCH FROM NORTH CAROLINA.

Exports of tar and pitch from North Carolina have varied during the past twenty years much less than have those of rosin and turpentine. The exports, both foreign and domestic, of these commodi-

*GRADES OF ROSIN.—The commonly recognized grades of rosin in the United States are as follows: "W. W."—water white; "W. G."—window-glass; "N."—extra pale; "M."—pale; "K."—low pale; "I."—good No. 1: "H."—No. 1; "F."—good No. 2; "E."—No. 2; "D."—good strain; "C."—strain; "B."—common strain; "A."—black.

"Water white" and "window-glass," which are the lightest colored and highest priced rosins, are made only from the "virgin dip," and usually only from that gathered during the first parts of the season. The virgin dip is the turpentine taken from the boxes the year or season that they are cut. The last dipping of the first season (the boxes are dipped from six to eight times during a season) give a yellowish turpentine which makes rosin of about the grade "N." The second and succeeding years "yellow dip" is obtained, the turpentine having acquired a decided yellow tinge of color from running down over the face of the tree which was hacked during the preceding summer when it comes in contact with the old and dark-colored resin on its surface, and is subject to the evaporation of the volatile oils in it by being longer exposed to the heat of the sun.

The second year's yellow dip makes usually rosin of the grade "N." during the first part of the season, while only darker grades "L." and "M." are gotten during the latter part of the season. Each year that the boxes are worked the dip becomes more colored, yields a darker rosin, and has less spirits of turpentine in it on account of having to run down a larger surface, covered with colored resin, and be exposed for a longer time to the oxidizing influences of the sun and air. The "scrape," which is the hardened resin adhering to the scarified face of the tree, yields the darker grades of rosin. The common grades are made from old scrape on trees which have been worked several years, and frequently has mixed with it sticks and chips, cut from the tree while the hardened scrape was being removed. The turpentine produced from the lighter colored dippings is of a better quality than that from the darker, being purer and lighter and having less rosin oil in it.

A large part of the dark grades of rosin ("strain" and "common") which are exported to Europe are used in manufacturing rosin oil. The finer grades are used in the manufacture of soaps, paper sizing, etc.

ties from Wilmington for the years 1874, 1884 and 1893 were as follows:

Total Exports of Tar and Pitch from Wilmington.

Year.	Tar, Barrels.	Pitch, Barrels.
1874	68,619	7,400
1884	68,794	5,734
1893	52,541	3,274

In 1893, besides the above, 4,600 barrels of tar and 700 barrels of pitch were shipped North by rail from Robeson and Cumberland counties. This makes a total of 57,100 barrels of tar and 4,000 barrels of pitch, with an estimated value of $65,000. The foreign exports of tar and pitch from Wilmington, for the years 1873, 1884, 1893 were as follows: In 1873 they were 48,200 barrels; in 1884 they were 20,138 barrels; in 1893, 7,740 barrels. This shows a decline in the foreign exports of more than 50 per cent. during each decade.

TOTAL AMOUNT AND VALUE OF NAVAL STORE PRODUCTS IN NORTH CAROLINA, 1893.

The total amount and value of the naval store products shipped from North Carolina during the year 1893 were approximately as follows:

Amount and Value of North Carolina Naval Store Products, 1893.

75,528 barrels of spirits turpentine	$1,283,760
367,981 barrels of rosin	392,000
10,931 barrels crude turpentine	12,000
63,100 barrels tar and pitch	65,000
Total value of products	$1,752,760

A preliminary report of the Eleventh Census estimates the total products for North Carolina for the year ending May 31, 1890, to have had a valuation of $1,705,833. No crude turpentine is given in that report and the tar is given at 600 barrels, valued at $847 for the entire State. This statement is evidently incorrect, since the exports of that product from Wilmington alone amounted to

72,000 barrels for the year 1890 and almost as much for the preceding year.

CONDITION OF THE TURPENTINE ORCHARDS IN NORTH CAROLINA.

As bearing on the future supply of resinous products in North Carolina, a close examination was made into the condition of the long-leaf pine forests now standing in the State, and in the following notes the writer has endeavored to show the character and extent of the existing productive orchards, of those orchards which have been abandoned, the round timber which can be boxed, and the second growth long-leaf pine.

LENGTH OF TIME THAT TURPENTINE ORCHARDS ARE WORKED.

The orchards of the Cape Fear river section have been worked steadily for from twenty to thirty-five years and in Sampson and Bladen counties many bodies of pine are reported as having three sets of boxes on them, having been worked since 1845, with intermissions of a few years for rest and to allow the space between the hacked faces to increase in breadth. The yield from these long-worked trees is still considerable when they grow on good soil, and when the trees have been injured in no other way, as by fire charring the faces of the old boxes.

These trees along the Cape Fear river seem capable of standing continuous working longer than those in any other part of the State or even of the United States, there being numerous reports from this section stating that the orchards had been worked from forty to fifty years. From Columbus county only one distiller reported that his trees had been worked as long as thirty-five years, while others stated that theirs were abandoned after having been worked from twenty to twenty-five years. One distiller in Robeson county, on the Cape Fear river, reported fifty years as the maximum time, while for those farther west, in Moore county, approaching the clay uplands and at an elevation of from 300 to 500 feet above the sea-level, a productive limit of twenty years was given. In South Carolina the trees are worked from twelve to fifteen years; in Georgia from four to eight years, except the slash pine (*Pinus*

cubensis Griseb.) along the coast, which "runs dry" in one or two years, as is true of the loblolly pine in North Carolina.

It may be said that most of the orchards now producing in North Carolina have been "back-boxed"* and that over four-fifths of the crude turpentine comes from back-boxed trees. Only in Montgomery and the western parts of Moore county are there any extensive bodies of trees which have not been back-boxed. The average time the trees have been worked in these two counties is about seven years, but many of the orchards in Montgomery have only been worked for four years.

AREAS OF ABANDONED TURPENTINE ORCHARDS.

An examination of this region showed that large areas of long-leaf pine forests had been abandoned as no longer profitably yielding turpentine. Such areas, where the trees are still standing, are classed by the distillers as *abandoned orchards*. When these forests have been removed by fire or cut by lumbermen and no loblolly pine has appeared to take the place of the long-leaf pine, the term *waste land* is applied to these areas. The following estimates of the amounts of abandoned orchards in the separate counties are based on returns made by 162 distillers in these counties, supplemented by personal investigation by the writer. These areas, in acres, of abandoned turpentine orchards were as follows in December, 1893:

Areas of Abandoned Turpentine Orchards in North Carolina, 1893.

Bladen county	60,000 acres.	Onslow county	38,000 acres.
Brunswick	98,000 "	Pender	28,000 "
Cumberland	51,000 "	Richmond	32,000 "
Duplin	17,000 "	Robeson	63,500 "
Harnett	52,000 "	Sampson	58,500 "
Lenoir	20,000 "	Wayne	30,000 "
Johnston	30,000 "	Wilson	20,000 "
Montgomery	10,000 "	Other counties	75,000 "
Moore	10,000 "		
Nash	25,000 "	Total in the State	718,000 "

Included in the term "other counties" are Wake, Edgecombe, Craven, Columbus, New Hanover and Carteret counties. The

*For explanations of this and other terms see pp. 94—96.

amount abandoned during the past few years has been greater than usual, the very low prices making it unprofitable to work thinly timbered orchards longer. The operation of many of these bodies may be resumed should there be any material advance in prices of naval store products, but such a change is hardly probable. In these areas of abandoned orchards there is a great range of density of forest growth, varying from that which may be called the normal density, which will cut from 3,500 to 4,500 feet, board measure, to the acre, to that which will scarcely cut 300 feet to the acre, below which latter limit it would be considered *waste land* unless a growth of loblolly pine has, in part, replaced the long-leaf pine. Although there is very little of this abandoned orchard that is heavily timbered with long-leaf pine, all of it has, more or less, valuable mill timber on it. Much of the timber might again be boxed and profitably worked if protected until the growth of the space between the boxes would allow new boxes to be cut.

ANNUAL ADDITIONS TO THE TURPENTINE ORCHARDS.

The number of acres of round timber being boxed yearly is now very small. An attempt was made to ascertain this amount, but both *back boxes* and *original boxes* were included in the returns; these figures, too, were somewhat fragmentary for certain districts. For the seasons 1892–'93 and 1893–'94 the *total number of boxes* cut in each county were about as follows:

Number of Boxes Cut in North Carolina, 1892–'94.

County.	Season 1892–'93.	Season 1893–'94.	County.	Season 1892–'93.	Season 1893–'94.
Bladen	86,000	95,000	Nash	60,000	60,000
Brunswick†	10,000	.....	New Hanover*	.....	.....
Columbus	60,000	70,000	Pender	33,000	22,000
Cumberland	255,000	220,000	Onslow	35,000	18,000
Duplin†	11,000	4,000	Richmond	90,000	65,000
Harnett	82,000	70,000	Robeson	197,000	96,500
Johnston	35,000	42,000	Sampson	114,000	105,000
Montgomery	35,000	60,000	Wayne	7,000	3,000
Moore	83,000	78,000	Wilson	.....	.....
Lenoir†	.....	3,000			
			Totals	1,193,000	1,011,500

*No returns made. †Returns not full.

It can be roughly estimated that it would require the trees on 20,000 acres to hold the number of boxes cut in 1893–'94. The proportion of this which was round timber, and which represents the increase in the area of orchard, was under 3,000 acres. The largest single tract ascertained to have been newly boxed was 350 acres in Bladen county. There were other tracts nearly as large in Sampson, Harnett, Richmond and Montgomery counties.

BOXING OF OTHER SPECIES OF PINES.

The loblolly and short-leaf pines are not generally tapped in this State. An attempt was made, however, to find out the number of loblolly pine (*P. Taeda*) boxes cut last year in Johnston and Robeson counties, where most of them are worked, and the number was found to be under 20,000, showing that a very insignificant amount of turpentine is produced from this tree. There were about 3,000 short-leaf pine (*P. mitis*) boxes cut last year in Montgomery county. This tree was extensively worked fifteen years ago in Wake and Chatham counties. The young trees are the only ones which yield sufficiently to justify boxing; they yield about two-thirds as much crude turpentine as the long-leaf pine and can be worked from six to seven years. The crude turpentine from the loblolly pine is very thin, and runs so freely that it usually overflows the box and runs down to the ground, unless the boxes are dipped more frequently than the long-leaf pine boxes are. It is said to have so much water in it that when distilled without a large intermixture of crude turpentine from the long-leaf pine only a poor quality of spirits turpentine is obtained.

AMOUNT OF ROUND TIMBER AVAILABLE FOR BOXING.

This name is given to the original growth of long-leaf pine before it has been boxed. It makes, of course, better mill timber than the boxed trees, which have the lower part of the stock around the face of the boxes surcharged with resin, obliterating all signs of the grain and making what is called lightwood. The amount of round timber, in acres, standing in each county December, 1893, was, as nearly as could be determined, as follows:

Amount of Round Timber (Long-leaf Pine) in North Carolina, December, 1893.

Bladen	3,900 acres.	Nash	700 acres.
Columbus	3,700 "	Onslow	3,200 "
Cumberland	1,300 "	Pender	5,400 "
Duplin	1,900 "	Richmond	2,200 "
Harnett	6,100 "	Robeson	6,850 "
Johnston	200 "	Sampson	876 "
Jones	400 "	Wake	700 "
Lenoir	1,500 "	Wayne	200 "
Montgomery	6,050 "		
Moore	10,700 "	Total for the State	55,876 "

The total amount of round timber now standing is very little more than was yearly being put in orchard during the period between 1840 and 1870. The number of acres of round timber standing in these same counties fifty years ago must have been between 4,000,000 and 5,000,000 acres. Much of this remaining timber will probably never be boxed, being in small bodies in districts where trees have ceased to be worked for turpentine.

YOUNG GROWTH OF LONG-LEAF PINE.

The young growth of long-leaf pine may also be included along with the round pine as timber which in part now, or in the near future, can be worked for turpentine. But unfortunately the acreage of second growth pine which is now, or even soon will be, of sufficient size to be boxed for this purpose, is very small, and the trees in such growth are scattering, consequently they are short-bodied and present little uniformity as regards size or regularity of growth. The figures for this acreage are based on field notes taken during an examination of the pine lands during the winter of 1893–'94. In each case they are probably much in excess of the true amount of young growth of trees large enough to hold a turpentine box. The counties in which any large amount of young growth was observed and the approximate amounts of this in each (in acres) are enumerated in the accompanying table:

Areas of Young Growth of Long-leaf Pine in North Carolina, 1893.

Bladen county	3,500 acres.	New Hanover	4,000 acres.
Craven	5,000 "	Robeson	2,000 "
Cumberland	2,700 "	Sampson	2,500 "
Moore	700 "	Others possibly	10,000 "
Lenoir	2,000 "		
Johnston	700 "	Total in the State	33,100 "

Some of this young growth has already been boxed, but the amount of turpentine gotten from it is inconsiderable. It varies in age from about eighteen to thirty-five years, and in diameter from four inches to eighteen inches. The amount of young growth loblolly and short-leaf pine is very large, should the price ever allow them to be extensively worked for turpentine.

DECREASING AREA OF TURPENTINE ORCHARDS IN NORTH CAROLINA.

As shown in the above statements the additions to the areas of turpentine orchards during the past few years, from both the taking in of new mature forests and the boxing of young or second growth pine trees has been small. On the other hand, the destructive agencies, such as forest fires, storms and the lumbermen, have been actively at work, and as the result of their combined activities the area of productive turpentine orchards in North Carolina has been reduced to but a small part of what it was half a century ago. Over the large areas north of Neuse river the long-leaf pine has practically disappeared. Over large areas between this river and the South Carolina State boundary line many of the once dense virgin long-leaf pine forests have given place to equally large areas of abandoned pine barrens and waste lands.

DESTRUCTION OF ORCHARDS BY FIRES.

Every year there is more or less destruction of standing timber by fires, both in worked and in abandoned orchards. The loss during the past year and the number of acres burnt over are shown with approximate accuracy in the accompanying tabulated statement:

Some of the Losses from Fires in Long-leaf Pine Forests, 1893.

Locality.	No. of Acres Burnt.	Loss.
Moore county	30,000	$25,000*
Cumberland	10,000	12,000†
Robeson	5,000	6,000
Six other smaller fires	3,500	5,000
Totals	48,500	$48,000

*Estimated by W. E. Petty, Esq., Carthage, N. C.
†Estimated by Mr. John Blue, of Aberdeen, N. C.

All of these fires took place in the spring, either in March or April, and all were reported as started from the firing of the grass of the pine barrens. The first two fires were particularly severe, going through orchards that were being worked, and ruining not only the boxes, but also killing a great deal of the timber, very little of which was so situated that it could be converted into lumber before being attacked by the borers.

In the fall of 1892 there was another severe fire in Richmond and Moore counties, which destroyed a large amount of timber, and also the village of West End, on the Aberdeen & West End Railroad. The value of the timber alone destroyed by this fire was placed at $75,000.

The danger and loss occasioned by fires in the forests is not sufficiently understood by the class of persons who are generally the cause of them. In the pine barrens most of the fires are purposely started, and the persons starting them should be held responsible for any loss caused by them. Too great discretion cannot be exercised about a suitable time to burn the woods, when it is deemed absolutely necessary to burn them, and persons should be careful that it is not too late in the season: after the trees have begun to put forth their leaves or shoots, and that the season is not too dry. Much care should be taken to prevent such fires escaping proper bounds and destroying the property of other persons who are in no way connected with the starting of the fire.

The damage of fires is more than local and the loss occasioned by them, or resulting from them, is felt far beyond the immediate district in which they occur. Even when there is no apparent damage it sets a precedent, the following of which is sure ultimately to lead to great damage. And there is always a considerable amount of damage done; enough to far more than counterbalance the advantages supposed to be gained in improving the pasturage of the forests or in other ways.

The illustration (Plate I) facing page 58 is from a photograph of a long-leaf pine forest a few miles west of Southern Pines, Moore county, taken some months after a forest fire had swept through this region. All of the pines at this point were killed. Many of them fell and were partially or completely destroyed, and

the few left standing were practically ruined, as they could not be cut at once. (See, also, pp. 57 and 61 for notes on the destructive work of forest fires).

DAMAGES TO ORCHARDS FROM STORMS.

Besides the injuries to turpentine orchards, during 1893, from fires they were damaged by two severe storms, occurring one in August and the other in October, in the fall. The earlier storm, in August, did but slight damage, except to abandoned orchards. The one of October 14th, however, proved generally destructive to all boxed pines, besides blowing up by the roots many oaks and other hardwood trees. The damages were greater in the south-eastern portions of the State, especially in Columbus, Bladen, Sampson and Johnston counties, but they were by no means confined to these counties. The force of the storm was not uniformly distributed over this area, but was more severe at numerous scattered points. Twenty distillers in these counties estimate that at least one-tenth of their trees were blown down, while other orchards were injured to a less extent, and several thousand acres of abandoned orchard were ruined.

Most of this fallen timber proved to be a total loss, though about 100,000 railroad cross-ties were cut from it at points contiguous to the railroads, and small quantities of it were carried to the sawmills on the Cape Fear river. Unboxed long-leaf pines suffered very little, and neither the loblolly pine nor swamp timber was damaged to any considerable extent. Boxed pines, as a rule, were broken off at the box. Out of one hundred prostrated long-leaf pines seen near Bladenboro (N. C.) eighty-five were broken off at the *box*, four above the box but along the *face*, ten were blown up by the roots, and only one tree was broken off above the face of the box. These facts show the importance of adopting some other system of gathering the turpentine which will avoid the deep boxing of the trees. Such a system is practiced in France, and is described further on in this report (page 96).

AREA OF ORCHARDS REDUCED BY LUMBERING.

Lumbermen are also instrumental to a considerable extent in reducing the acreage of turpentine orchards. In Moore, Richmond and Robeson counties they are rapidly cutting into the orchards. Eleven distillers in the two first counties reported their orchards as having been cut into by lumbermen last year. At least 35,000 acres of new and abandoned orchard must have been cut over during 1893 to have yielded the lumber cut during that year by the mills sawing long-leaf pine.

HOW LONG CAN OUR TURPENTINE ORCHARDS LAST?

It appears from the foregoing that there are in the State less than 75,000 acres of long-leaf pine timber now unboxed which can be added in the future to the turpentine orchards, and that the present yield of turpentine is derived principally from "back-boxed" trees, which if not destroyed within twenty years could not continue to yield turpentine for more than that length of time. In point of fact, however, the trees of existing orchards cannot produce turpentine, except in a small way, for even that length of time, since they are being destroyed by fire, or converted into lumber, at the rate of over 60,000 acres a year. Then, too, the rate of destruction increases each year as the number of mills increases, and as the amount of abandoned orchard, which proper precautions are not taken to protect from fire, becomes larger; and these abandoned orchards serve as means of carrying fire to the newer orchards which are being used.

FRENCH AND AMERICAN METHODS OF GATHERING TURPENTINE.

The two chief objections to the American system of boxing trees for turpentine are:

(1). The injury to the tree produced by the box, interrupting and impairing the life processes and sooner or later damaging the timber or causing its entire destruction, and,

(2). That the yield of spirits of turpentine is less than it should be, and the rosin manufactured is largely of darker and inferior grades.

A method of tapping the trees, which to a very great extent

remedies these faults, is the Hugues system, which was first used in France about 1860, and since that time has come into general use in that country, having been found more efficacious than the one previously used there. It presents as great an advancement on the American system now in vogue as the American did on the early French method.

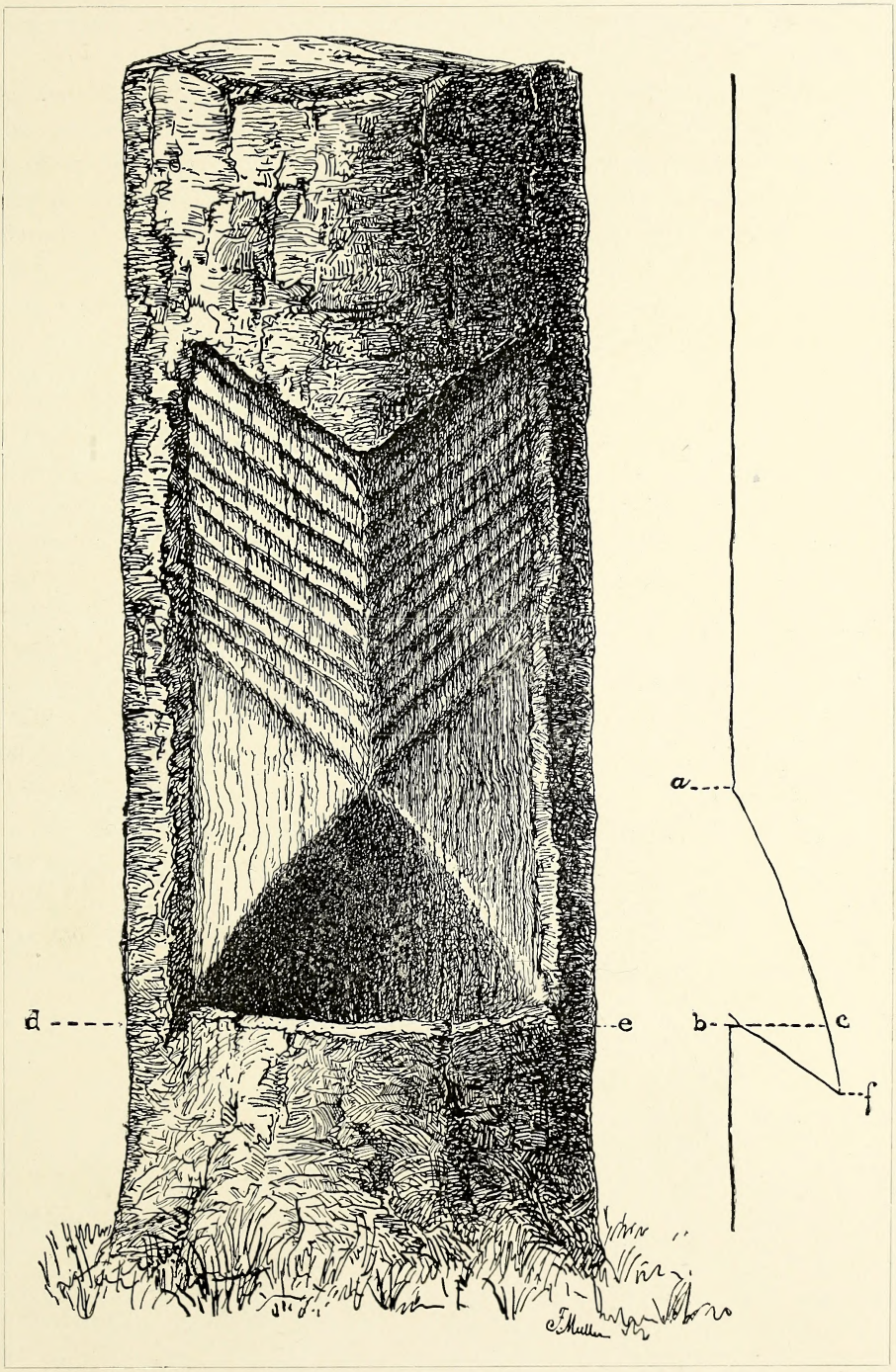
THE AMERICAN SYSTEM OF GATHERING TURPENTINE.

The American method, which can be advantageously used only on stocks over fifteen inches in diameter, consists of cutting in the base of the tree, about eight inches from the ground, a hole called the *box*. This box, which is hollowed out with a narrow, thin-bladed axe manufactured for the purpose, has a length following the circumference of the tree of about fourteen inches (*d* to *e* of Plate II), a depth of about seven inches (*b* to *f*), and extends back into the wood at the mouth of the box about four inches (*b* to *c*), or at the bottom of the box (*f*) about five inches. At the same time that the box is cut there is a triangular strip removed on either side of it and extending up as high as the tip of the box. This operation is called *cornering* and the channels left where the chips were removed act as gutters leading into the box.

Immediately above this box the thin bark and a thin section of the sap-wood is removed by means of a sharp, bent-bladed implement called the *hack*. In this process, called *hacking* or *chipping*, the implement is drawn at an oblique angle across the surface of the trunk alternately in opposite directions, each pair of grooves made by the hack forming a V, so that the cut surface consists of two planes forming a very obtuse angle, the lines of their union running vertically up the tree above the center of the box, and down which line the resin runs into the box. This scarified surface, called the *face*, has a breadth of from fourteen to sixteen inches and a depth usually of one and one-half to two inches, rarely going in as deep as the thickness of the sap-wood.

The boxes are cut late in fall or early in spring, and in the first part of March chipping is begun, and is repeated about once a week for from thirty to thirty-five weeks, according to the

North Carolina
State Library.



AMERICAN PRACTICE OF BOXING AND CHIPPING.
[FROM U. S. DEPT. AGR. REPT.]

length of the summer season and the way the resin runs. At each chipping about one-half an inch of wood is cut off. The resin lying in the resin ducts or pores, which are parallel with the grain of the wood, flows out when these ducts are cut and runs down into the box. The object of repeated chipping is to open a fresh surface for the exudation, when the ducts have become clogged by an accumulation in them of hardened resin. By the end of the first season the face has been carried up eighteen to twenty four inches above the box.

The resin which runs into the box, called *virgin dip* the first season, and the *yellow dip* of subsequent years is a thick, viscid liquid, more or less transparent and thinner the first season, but hardening quickly on exposure. During the first season it is removed seven or eight times from the box. That resin which hardens on the face is removed by a sharp *scraper* (*scraping*) and is mixed with chips and bark, and, besides containing only one-half as much spirits of turpentine as the dip, makes a much harder and darker and withal less valuable grade of rosin than the dip, much of the spirits of the scrape having evaporated or oxidized under the influence of light, heat and air. Each year as the face is carried up higher, about twenty inches a year, there is more scrape and less dip, as the resin exuding from the freshly hacked surface has to run over the entire surface which has already been hacked before it reaches the box, and a large proportion of it hardens and never reaches the box.

The *dip*, as has been explained, becomes, in succeeding years, gradually darker as work is carried on until it makes only a slightly better rosin than the scrape and contains only two-thirds as much spirits of turpentine as the virgin dip gotten the first year the boxes were worked. There will average two such boxes to a tree, the trees generally being about twenty inches in diameter. After the "faces" have been carried up so high that it is no longer profitable to work them, the trees are allowed to rest for several years and recuperate. During this time the sound wood left between the "faces" broadens, partly covering the old faces, so that on large trees new "boxes" can be cut in between the old ones and

the trees again worked. This is called "back-boxing." There are frequently three sets of boxes put on one tree.

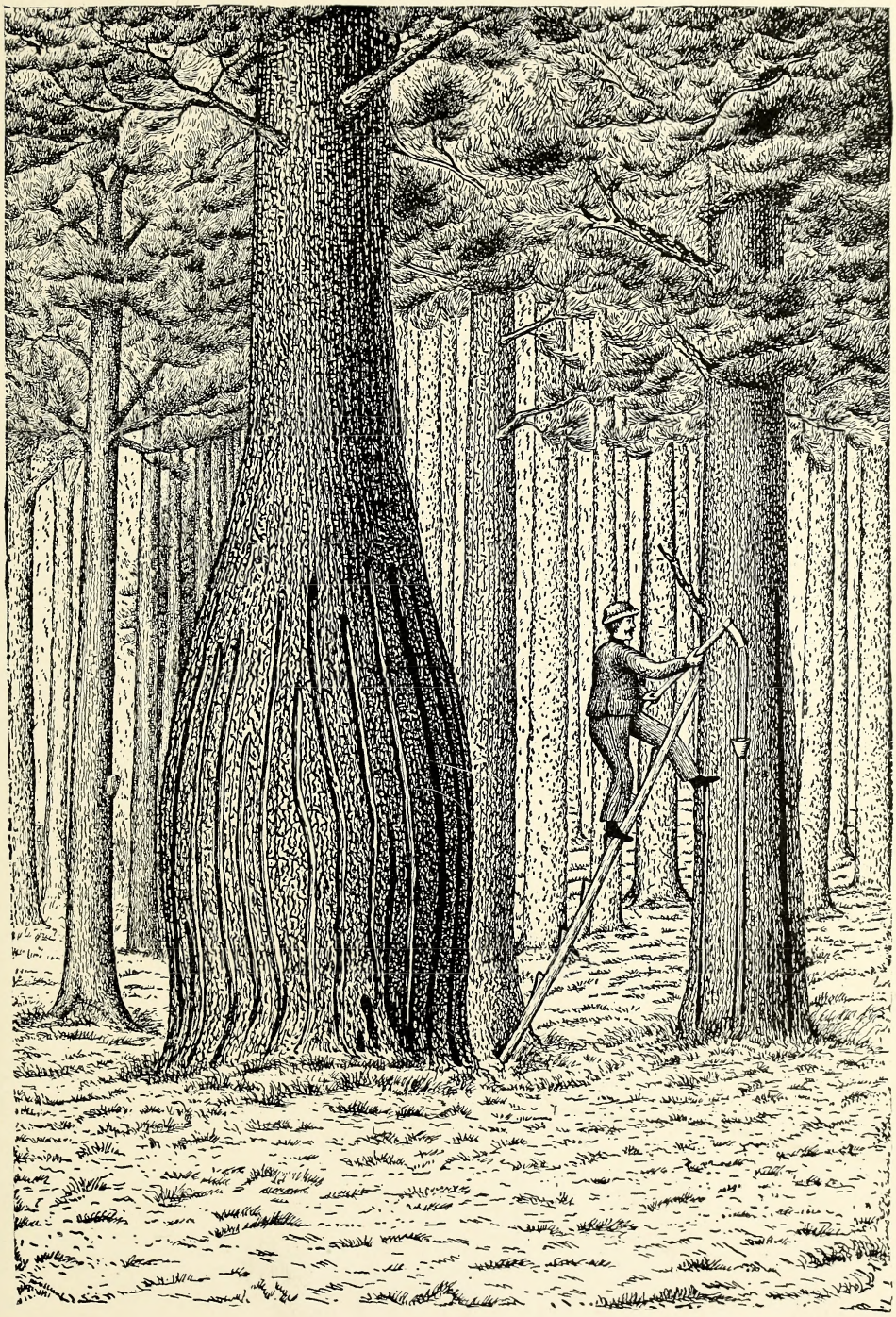
THE FRENCH SYSTEM OF GATHERING TURPENTINE.

The original French method merely removed the bark and a thin layer of sap-wood from a space (face) about five inches wide on each tree, and the resin as it exuded after the repeated chippings ran into a receptacle placed at the foot of the tree to receive it, or frequently into a hole dug in the sand. By the latter method, which was very primitive, the turpentine was mixed with sand, the spirits was absorbed and only a poor grade of rosin was made from it.

The method adopted in 1860, when the production of turpentine was stimulated in France owing to the stoppage of American exports by the blockades during the civil war, was very much in advance of this. The new method, then adopted, may be described in general terms as follows: At the end of February the outer bark for a considerable height is removed on all trees which are to be tapped that year, leaving only a thin layer of bark over the sap-wood. This is to prevent loose bark from falling into the resin. At the first of March, with a peculiar-shaped implement resembling an adze with a bent handle and a curved blade, there is made near the foot of the tree an incision which is four inches broad, two inches high and only one-third of an inch deep. At the bottom of this incision a curved gutter of zinc or galvanized iron, which has a width of the hacked face and teeth on its inner edge, is driven into the wood. This gutter turns the more liquid resin, which flows down into an earthenware or zinc cup hung on a staple immediately below the gutter.

The accompanying illustration (Plate III), taken originally from Professor L. Boppe's work on Forest Technology, but here reproduced from the Annual Report of the Chief of the Division of Forestry, U. S. Department of Agriculture, for 1892, "represents a pine two hundred years old, with more than fifty scars or chips, without apparently any ill effects on the life of the tree."* Some

*An. Rept. Secretary of Agr., Washington, 1892, p. 348.



TURPENTINE ORCHARDING IN FRANCE.
[FROM THE U. S. DEPT. AGR. REPT.]

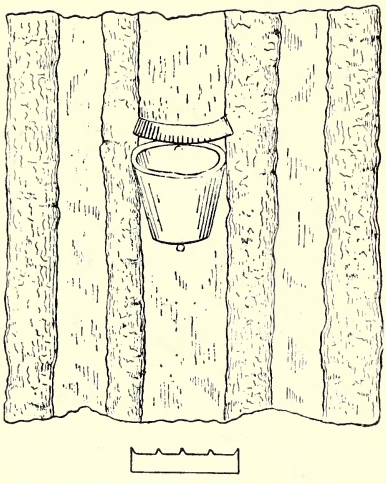


FIG. 1.—TURPENTINE GATHERING (FRENCH SYSTEM), TILL AND POT.

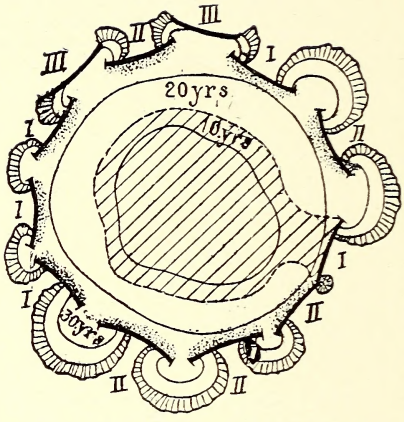


FIG. 2.—CROSS SECTION OF TURPENTINE TREE (FRENCH SYSTEM).

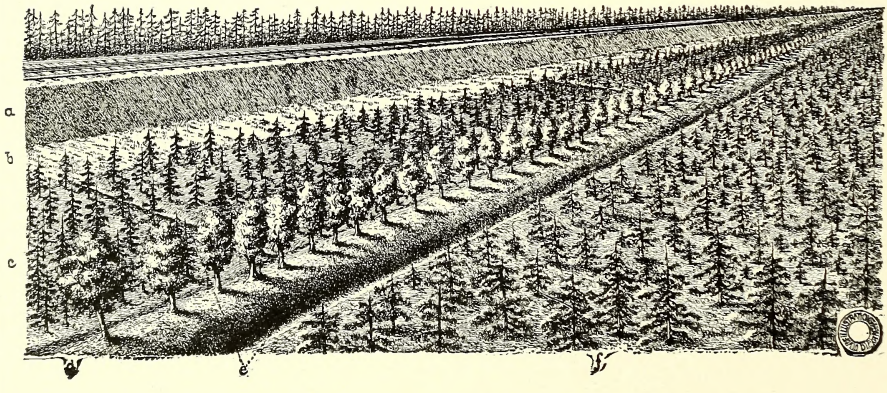


FIG. 3.—FIRE-SAFETY STRIP ALONG RAILROAD, FRENCH TURPENTINE FOREST.
[FROM U. S. DEPT. AGR. REPT.]

of the details of the method are more clearly shown in the figures 1 and 2 of Plate IV.

Figure 1 of Plate IV "exhibits the method of gathering turpentine by the Hugues system, and the use of the till and pot. While formerly the resin was allowed to run into a hole in the sand at the foot of the tree, since 1860, when the production was stimulated by the closing of the American sources of supply, an improvement on the crude method of collecting came into use. It consists in fixing a bent zinc collar or gutter cut from sheet zinc eight inches long and two inches wide, with teeth (see figure) across the chip, which acts as a lip, and conducts the liquid resin into a glazed earthen pot or a zinc vessel of conical shape suspended below the lip. The pots are six inches high, four and a half inches at the opening, and three inches at the bottom, and hold about one quart. At first placed on the ground they are fastened each season above the old chip by means of a nail through a hole or otherwise (see figure). In this way, by shortening the distance over which the resin has to flow, the evaporation of the oil is reduced and there is less liability of impurities to fall into the receiver. A cover over the pot is also sometimes used. The pots are emptied every fifteen or twenty days with the aid of a spatula. The scrape is collected only twice in the season, in June and November."*

Figure 2 of Plate IV shows a cross section of a pine tree treated according to the French method, bled at different places at different times. Some of the scars are nearly covered over with new wood (as at II), and two of the scars (as at III) have been recently made in new wood between older scars.

"Another improvement which reduces the amount of evaporation and assures cleaner resin consists in covering the chip with a board. This improvement (Hugues system) is said to yield more and purer resin, the yield is claimed to be about one-third larger, and the difference in price, on account of purity, 80 to 90 cents a barrel, while the cost per tree per year is figured at about one cent, besides the proportion of scrape is considerably reduced. This (called gallipot) is collected by hand, except the hardest impure parts (called barras), of which there is hardly any in this system of

*An. Rep. Secretary Agr., Washington, D. C., 1892, p. 350.

collection. Not more than 17.9 per cent. of scrape is expected, as against 29 in the American practice."*

Figure 3 of Plate IV "shows safety fire strip along railroad; *a* is the elevated roadbed, *b* is a strip of ground about twenty-five feet wide, which is cleared of all inflammable material. Alongside of this the wooded safety strip about fifty to sixty feet wide; *c* is a ditch five to six feet wide, a foot or so deep, the soil being thrown toward *d*. Cross ditches are made through the safety strip every 300 feet. The total width of the whole system of the road on either side is, therefore, eighty to ninety feet. The strip *b* may be used for agricultural purposes if fit for it; strip *c* remains wooded, but the forest floor is cleared out and freed of all inflammable material."†

Chipping is done forty to fifty times a season, and by the end of the first season the chipped surface has reached a height of twenty inches; that is, while the face is carried in one season just about as high in France as in the United States it is hacked from twelve to fifteen times more in the former country than here. This cup can be emptied easily and quickly by lifting it off the tree, and to prevent it being broken can be set aside while hacking and scraping is in progress, which latter operation is done once a year, in the fall. When work is begun on the second and subsequent years the cup and gutter are moved up and refastened so as to be just under the newly hacked surface. The face is rapidly carried up, the tree being hacked more frequently, but a much thinner chip being taken off than is required in the American practice, preserving all the time about the same width and same depth, so that at the end of five years it has reached a total height of twelve feet. From one to ten such faces are put on the pines, according to their size and age, and whether they are to be bled to death (*gemmage à mort*), in which event the timber will at once be utilized, or bled as long as the tree lives and an abundant flow of turpentine will permit (*gemmage à vie*).

These faces are worked only five years and then the tree is allowed to rest several years before new ones are put in. The new faces must be put in so that they will be four inches from any other

*An. Rep. Secretary Agr., Washington, D. C., 1892, p. 350. †*Ibid.*

faces, in order that not enough of the inner bark and sap-wood will be removed at one time to kill the tree or seriously injure its life.

ADVANTAGES OF THE FRENCH SYSTEM.

The advantages of the French over the American system fall under two heads: (1). It tends more to protect the trees and prolong their activity. (2). It gives a larger yield, raises the grade of the resinous products and lessens the cost of producing.

RESULTS AS TO THE RELATIVE STRENGTH AND VITALITY OF THE TREES.

Under the French system no "boxes" are cut to weaken the trunk and make it liable to blow down, and in which, sooner or later, rot begins and finally destroys the timber value of the stem. It is in this American "box," too, always filled or covered with inflammable resin while the face is being worked, that fires usually get a start on the tree. There is no limit to the number of new sets of narrow French faces which can be placed, while from the weakening caused by the boxes only a limited number of sets of them can be cut. There are trees in the canton of Cormeau (France) which have been worked for more than 200 years and show over fifty scars. The scars of the narrow faces, although they may be over twice as numerous, are more quickly covered over by the growth of new wood on both sides, since the cambium or generative tissue just under the bark will have twice as many surfaces from which to develop. This enables a tree to more quickly regain its lost vitality, upon which the yield of resin largely depends. The shallow depth which the faces in the French practice are cut, only one-third of an inch, does not injure the life process so much as the deeper cutting practiced in America, which injures the growth of the tree about two-thirds, as is shown by a comparison of the thickness of individual rings of growth before and after boxing.

The purpose the French management has in view is to both preserve and work the forests intended for the production of turpentine as long a time as possible without serious injury to the trees,

since it is a matter of both time and expense to grow a body of pines suitable for tapping.

THE YIELD BY THE FRENCH SYSTEM LARGER IN QUANTITY AND BETTER IN QUALITY.

By using the cup for collecting the turpentine and moving it up each year, so that it will be just below the freshly hacked surface, a larger quantity of purer and lighter colored dip is gotten than would be possible under the American plan, and the material thus collected corresponds always to the virgin dip; it is very free from bark and makes an exceedingly high grade rosin. Under this arrangement there is very little scrape, the surface hacked that season being all that has scrape on it. The increased production in France by use of the cup method amounted to four pounds of spirits of turpentine and seven pounds of rosin from every 100 pounds of crude turpentine, and besides there were no chips or trash of any kind in the crude material. The spirits of turpentine manufactured is of a better grade than that made from crude turpentine collected by the old method, being distilled at a lower temperature and with less heat, and all of the rosin, except a small proportion made from the scrape, is of a high grade.

The value of a barrel of the crude turpentine collected by the cups is about one-fourth greater than that collected by the former system. By the cup method there is also a large saving in labor, both in scraping and dipping, and there is no loss of turpentine in dipping from a box to a bucket.

RESULTS OF EXPERIMENTS WITH THE FRENCH SYSTEM IN NORTH CAROLINA.

During the season of 1894 a trial on a limited scale was made to test the merits of the French system and to ascertain by its direct application to the long-leaf pine the exact increase of turpentine collected by it above that yielded by the American practice.

In order to reduce to a minimum the chance of errors it was decided to conduct the experiments at three separate stations under direction of different persons. At two of these stations the turpentine was to be gotten from second-year boxes and at the third

station it was intended to begin a trial with first-year or virgin boxes and continue the work here for several consecutive years to ascertain the comparative annual yield.

Unfortunately in one set of the experiments with second-year boxes the value of the results was vitiated by reason of a considerable loss of turpentine from the receptacles' overflowing. The results in this case will not be considered. Careful and conscientious attention seems to have been given the third set by the person in charge, and the results seem to be of sufficient importance to be given in full. The superintendence of this work during the season was in charge of Mr. Singletery, of Bladenboro, N. C., and it was near this village that the experiment was conducted.

The pines selected for tapping were in a grove with a medium density (about seven), and had an average circumference, breast high, of six feet nine inches. These were by no means the largest trees in this grove, but were selected on account of their vigor and apparent healthiness. The soil was fair, being a moist sandy loam. The forest floor was poor, being covered with a heavy growth of wire-grass, broom grass and low huckleberries. This strip had not been burnt in several years, and since the locality was isolated, being located in the neck of a small swamp, there was little likelihood that a fire would interfere in any way with the carrying out of the experiment. Boxes, usually two to a tree, had been cut in these trees in the previous spring and the trees "worked" for one season (1893), so that there were faces twenty inches in height on each tree. Those faces were from thirteen to fifteen inches broad. Six of these old boxes, with nearly southerly aspects and with faces unshaded by surrounding shrubs, were chosen as suitable for our purpose. Above each of these old faces two narrower faces (each six inches broad) were begun side by side. This method of placing the narrow faces gave each pair of them nearly the same aspect, and since, so far as could be seen, they were under similar conditions and of the same breadth, the amount of resin which flowed from each should have been the same. Six pairs of these narrow contiguous faces were begun above the broad ones on as many different trees, care being always taken that both narrow faces of any one pair were of the same breadth.

The surface of one narrow face of each pair was continuous with the surface of the face below, which was hacked during 1893, and the turpentine which exuded from the freshly chipped surface of this narrow face was allowed to run down the entire surface of the old face into the box cut at the foot of the tree.

Across the base of the other narrow face, which began at the upper edge of the old face, a metal gutter was driven into the wood. This gutter turned the turpentine into a metal cup which hung on a staple beneath it. Chipping was begun on these faces April 20th. Both of these narrow faces were hacked at the same time and the same number of chips were taken from each face, so that the length of both faces was kept equal. Both the metal receptacles and the boxes were emptied six times during the running season. The turpentine taken from the boxes was such yellow dip as is commonly collected from second-year boxes. The grade of the turpentine collected in the metal cups was virgin dip, exceedingly free from bark, leaves and chips. It will be understood, from the fact that each of the narrow faces had a breadth of only six inches, that from the six faces in either set there should have exuded only about as much turpentine as is usually collected from three of the large-size faces, fourteen inches broad.

The net weight of the turpentine collected by all of these boxes was 21 pounds; the net weight of that collected by the cups was 24 pounds and a few ounces; that is, by the use of the cups there was a gain of one-seventh in the weight of the dip collected; or had the faces been as broad as they are usually made there would have been during the summer a gain of one pound to each face. The yield of 7 pounds to a box from these picked trees is about one-fifth more than the average yield, which is only between 5.5 and 6 pounds to a second-year box. However, this is immaterial. What we are after is the percentage of the increased yield collected in the metal cups above that of the boxes. This increase was about 15 per cent. in favor of the cups. The application of this to a crop of turpentine would mean considerable aggregate gain and would show more clearly how large the gain really is.

Working out the increased yield on this basis, *i. e.*, one pound

to each box, there would be a gain of 10,000 pounds of dip to a crop of 10,000 boxes, or a gain of 35.8 barrels of dip above the 250 barrels which 10,000 boxes would have produced had each box yielded 7 pounds; or there would be gotten, instead of the 250 barrels of yellow dip from the boxes, 285.8 barrels of virgin dip by use of the cups. The difference in the amount of scrape yielded by the two systems was not near so large as the difference in the amount of dip. This difference, of course, was in favor of the boxes and amounted to less than two pounds from all six of the boxes. This loss of a pound or more was due to the loss of volatile oil by evaporation and loss of scrape which hardened on the old faces. This difference in favor of the boxes would amount in a crop to nearly 23.5 barrels of scrape.

The advantage in favor of the cups, however, lays not only in the increased yield in pounds of turpentine, but also in the higher grade of product obtained by the cups. The value of the entire yield of a crop of 10,000 boxes as determined above would amount, at present prices, to about one-fifth more if collected by the cup than if collected in the boxes. This difference in value would be distributed as follows:

Value of 285.8 barrels of virgin dip at $1.70 per barrel,		$ 485 00
Value of 250 barrels of yellow dip at $1.50 per barrel.....	$ 375 00	
And value of larger yield of 23.5 barrels of scrape at $1.10 per barrel.....	26 00	401 00
Difference in favor of cups.....		$ 84 00

There is an increase in value amounting to $84, or over 20 per cent. gain, even when the cups are substituted in the place of second-year boxes, and the rate of increase in value of products becomes larger each succeeding year.

As in the other experiment both cups and boxes were tried on first-year faces, of the same length, no difference is expected in the result in favor of either system. It was intended, when this experiment was begun, to move the cups, at the middle of the season, up to the top of the face which had at that time been chipped. This should have yielded, in the cups, a slightly larger amount of dip turpentine than was collected in the boxes, and the grade of

that in the cups should have been higher, since the dip turpentine collected from first-year boxes is usually classed as yellow dip for the last dippings of the season.

It is expected that these experiments will be continued next season (1895) on a larger and even commercial scale to make a further test of their adaptability. This will include a test of the cheapest and most serviceable collecting cups, the best breadth to make the faces, and a trial of different materials for making gutters to ascertain their durability and strength. The use of materials with minimum cost and maximum utility will of course determine the commercial practicability of the system and it is these subjects which it is hoped will be thoroughly investigated during the next year.

The incomplete results from another experimental trial, in which the cups, on first-year faces, were, at the middle of the season, moved up so as to be at the top of the face which had so far been cut, show a gain in the number of pounds of dip collected even larger than that obtained in the preceding trial. As no scrape was collected in this trial, from a misunderstanding with the person in charge, the weight of the scrape cannot be included. It can be said, however, that there was a large difference in the amount of scrape on the two sets of faces, much the larger amount of scrape having settled on the faces with boxes.

There were twelve faces in each set, the arrangements being similar to those stated in the above experiment, except that these faces were broader—from 7 to 7½ inches—and instead of the faces being cut in pairs, one of each kind, they were placed two on each tree without regard to their aspect. The net weight of the turpentine collected from the twelve boxes was 50½ pounds, and the weight of that collected from the cups was 59 pounds, which gives a net yield in favor of the cups of 8½ pounds, or a gain of over 16 per cent. No difference in the grades was noticed in the turpentine, both being classed as virgin dip.

COST OF ADOPTING THE FRENCH SYSTEM.

The cost of the change from the old French method to the modern Hugues system was stated by Desnoyers (chief forest guard of the national forests of France) to be about one cent a year for each

tree. To change from the American to the Hugues system it would not cost that much, for the cutting and cornering of the boxes, allowing two boxes to a tree and 1.4 cents for the cost of each box, amounts to nearly three cents for each tree the first year; and by the American practice one-fourth of the total yield of turpentine for six years is obtained during the first year. In the French orchards, on the other hand, the yield is very nearly the same for each year. The cups, which are made of glazed earthenware, have a hole near the upper rim which can be slipped over a hook or staple driven in the tree. Thick galvanized iron makes better gutters than zinc, as the former stands driving better and is much less injured by atmospheric influences. It is cut in strips four inches long and one and one-half inches wide, one of the longer sides being cut obliquely to the surface so that it can be easily driven into the sap-wood of the pine.

The above-mentioned facts concerning the tapping of the pine in France are taken from Samano's *Treatise on the Culture of the Maritime Pine;* Desnoyers' *Tapping of the Maritime Pine;* Prof. L. Boppe's *Forestry,* and *The Naval Store Industry* in the Report of the Chief of the Division of Forestry in the U. S. Department of Agriculture for 1892. This last mentioned publication has a very clear and concise account of the different methods of tapping, with the advantages and disadvantages of the different systems, and is well illustrated. It can probably be obtained free of charge by any one desiring to know more of the merits of the Hugues system and the condition of the naval store industry in other parts of the United States and in foreign countries.

CHAPTER IV.

THE LUMBER INDUSTRY IN EASTERN NORTH CAROLINA.

HISTORICAL SKETCH.

Until within the past two decades the production of lumber in eastern North Carolina, except for local use, had been small, owing to the great distance from general markets and the limited demand for the hard pines. Wilmington, as early as the middle of the last century, had considerable trade in long-leaf pine lumber with the West Indies and England, and this trade continued in a limited way until the first part of the present century, when with the use of steam in sawing the output was largely increased. Mr. James Sprunt, in his "*Information Concerning Wilmington, N. C.,*" says that the first steam saw-mill established in Wilmington was erected on the western side of the Cape Fear river by a person named Mazerretti in the year 1818.

For a great many years after this Wilmington had a large and growing trade in lumber with the West Indies, but of late years the competition of Savannah, Mobile and Pensacola, which are much nearer to these islands, has prevented any farther expansion of the industry in that direction. Wilmington has always had a large trade in lumber with the Middle and New England States, where the long-leaf pine has been largely used in ship-building, etc.

In the last few years, owing to the increased demand for Southern hard pine, the number and capacity of the mills at Wilmington have been more than doubled. The logs for supplying this demand come from the counties along the Cape Fear, Black and North East rivers and their tributaries, along which lie well-timbered cypress, long-leaf pine and loblolly pine lands. The territory drained by these streams is about 5,000 square miles, over one-fourth of which area is timbered with long-leaf pine that can be floated to Wilmington.

As early as 1830 both Newbern and Washington had large trades in long-leaf pine lumber with foreign ports, mostly in the West

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Indies. By 1860, however, owing to the exhaustion of the long-leaf pine in these sections, their trade had ceased, and since that time these points have become centers for the production of loblolly pine lumber.

Loblolly Pine in the Timber Market.—As the supply of long-leaf pine became exhausted north of the Neuse river other pines were used in its place, the short-leaf pine being the next used and then the loblolly. In many sections these latter have always been the only pines available for building materials.

It is only within the past thirty years, however, that the loblolly pine has entered the general market in the form of lumber, being debarred, previous to that time, because of the fact that so large a proportion of it is sap wood. If used where exposed to the weather it decayed rapidly, and when used for interior work had to be painted, since it "blued" badly. The introduction of dry kilns, which enabled the sap to be thoroughly driven from the timber and the wood perfectly dried, has given it a wide range of uses. Now there is a steady demand for it, as it is extensively used for flooring, ceiling and other interior wood-work, and also for exterior work, for which latter use it is suitable only when thoroughly dried and painted. In the Northeastern States it is being used as a substitute for white pine and spruce, and as the better grades of these become scarcer and consequently more valuable the demand there for loblolly pine lumber increases and the uses to which it is put become more varied.

Since this is the chief timber tree over a large part of the State, it has been used for many years, in the section where it is the only pine, for building and fencing material. For these domestic uses only the largest stocks, and those with the most heart, were selected. For the manufacture of kiln-dried flooring and ceiling, however, those trees are preferred which have the least heart, since the sap wood furnishes a lumber more uniform in quality and color than the heart. Lumber made from the sap wood is also lighter than that from heart wood and the cost of transportation is less. It is marked in the New England and Middle States where it is sold under the name of "North Carolina pine," "North Carolina sap pine," or "North Carolina kiln-dried pine."

There has been a considerable increase in the value of loblolly pine stumpage since it has entered the general lumber market. Twenty years ago loblolly lands ranged in value from 50 cents to $1 per acre, according to situation in relation to transportation facilities and density of growth. Land similarly situated and timbered now sells from $1 to $5 an acre. Original growth loblolly lands will cut from 3,500 to 6,000 feet, board measure, to the acre; second growth from a third to a half less.

STATISTICS OF THE LUMBER INDUSTRY.

The statistics for this report on the saw-mill and forest industries of eastern North Carolina were collected in connection with an investigation of the timber lands of this section, which has just been completed. It is intended more to show the condition of the various branches of the lumber and allied industries, in respect to output and supply, than to give a general treatment of the different departments of the aggregated interests. In this connection there are but imperfect statistics for comparison, these being chiefly estimates prepared for lumber journals.

The area treated of embraces forty-three counties, which constitute the original "long-leaf pine belt" of North Carolina and to which, according to the U. S. Census of 1880, four-fifths of the milling interests of the State were at that time confined. In this enumeration are contained the products of all saw-mills and planing-mills, whether operated in connection with saw-mills or as distinct establishments, excepting entirely local planing-mills and door, sash and blind factories connected with these or distinct. There are in this section ten such local planing-mills and blind factories, which have an output with an estimated value of between $100,000 and $250,000 per annum. In spite of the fact that the latter half of the year 1893 was an era of business depression, and consequently there was a curtailed output, there is a marked increase shown in the value of the output of 1893 over that of both 1890 and 1880, according to the census reports for those years.

The value of rough and remanufactured lumber, including shingles, produced in this "long-leaf pine belt" of North Carolina

for the year ending December 31, 1893, was about $4,559,000. For the census year 1880 it was $1,340,000, and for the census year 1890 it was, for the entire *State*, $5,767,687.

The output for 1893 came from 323 lumber-mills, including shingle-mills, with an aggregate capital of $4,690,000. The capital reported by the census, for the entire State, in 1890 was $5,319,-500, invested in 688 establishments.

The capital engaged respectively in the manufacture of shingles and board cannot be separated, since the manufacture of shingles is largely engaged in by mills producing other lumber products. The number of mills engaged in the manufacture of lumber was 281, with an output in 1893 of 455,865,000 feet, board measure, valued at about $3,745,000. The number of shingle-mills was 65 (42 exclusively shingle-mills), with an output of 166,180,000 shingles, valued at about $813,280.

OUTPUT OF LUMBER AND SHINGLES.

The output of lumber and shingles and the capacity of the lumber and shingle-mills in operation in each county for the year ending December 31, 1893, was as follows:

Output of Lumber and Shingles, Eastern North Carolina, 1893.

Counties.	Number of Establishments.	Lumber.		Shingles.	
		Output in 1893, in feet, board measure.	Yearly capacity in 1893, in feet, board measure.	Output in in 1893.	Yearly capacity in shingles, 1893.
Bladen	5	2,800,000	5,400,000	3,500,000	5,000,000
Bertie	7	1,940,000	5,000,000	3,000,000	5,000,000
Beaufort	13	28,350,000	35,000,000	4,000,000	6,000,000
Brunswick	3	*2,000,000	3,500,000	.....	.....
Camden	5	4,500,000	6,000,000	1,300,000	4,000,000
Carteret	3	6,700,000	8,000,000	.....	.....
Chowan	6	24,400,000	30,000,000	3,000,000	4,500,000
Craven	16	46,700,000	53,500,000	12,300,000	15,800,000
Columbus	8	13,400,000	24,000,000	15,100,000	25,000,000
Cumberland	10	10,500,000	18,000,000	.....	.....
†Currituck	.....	.....	.....	.....	.....
Dare	5	*2,000,000	4,005,000	6,000,000	10,000,000
Duplin	6	1,800,000	3,000,000	.....	.....
Edgecombe	9	*2,850,000	4,000,000	1,500,000	3,500,000
Gates	6	2,700,000	4,500,000	780,000	1,600,000
Green	11	2,300,000	5,000,000	1,500,000	2,200,000
Halifax	5	*8,000,000	14,000,000	.....	.....
Harnett	5	6,800,000	8,500,000	.....	.....
Hertford	4	3,800,000	‡.....	2,500,000	4,500,000
Hyde	5	6,900,000	10,000,000	3,000,000	4,000,000
Johnston	7	*7,600,000	13,000,000	.....	.....
Jones	5	2,200,000	3,000,000	3,700,000	2,000,000
Lenoir	13	20,300,000	25,000,000	8,200,000	13,000,000
Martin	10	19,500,000	30,000,000	15,000,000	19,000,000
Montgomery	3	2,300,000	3,000,000	.....	.....
Moore	30	32,320,000	49,000,000	1,900,000	4,700,000
⁒Nash	6	3,550,000	4,800,000	.....	.....
New Hanover	8	36,000,000	48,000,000	1,500,000	1,500,000
Northampton	5	*5,800,000	8,000,000	.....	.....
Onslow	3	14,500,000	16,000,000	.....	3,000,000
Pamlico	7	11,700,000	15,800,000	.....	800,000
Pasquotank	13	22,500,000	30,000,000	19,500,000	23,000,000
Perquimans	6	4,900,000	7,000,000	3,000,000	3,900,000
Pitt	10	7,000,000	10,000,000	3,000,000	4,500,000
Pender	5	900,000	1,500,000	3,300,000	4,800,000
Robeson	12	14,700,000	18,300,000	4,000,000	7,000,000
Richmond	12	12,000,000	17,500,000	1,700,000	3,300,000
Sampson	9	1,670,000	3,800,000	400,000	950,000
Tyrrell	3	4,500,000	6,000,000	7,000,000	9,000,000
Washington	6	34,500,000	40,000,000	27,200,000	32,000,000
Wake	9	6,000,000	10,000,000	2,000,000	2,800,000
Wayne	6	8,600,000	10,000,000	300,000	1,800,000
Wilson	3	1,500,000	2,800,000	.....	.....
Totals	323	452,880,000	625,000,000	159,180,000	208,150,000

The figures show the quantity of lumber manufactured in each county rather than the amount cut in each. In some cases logs were carried to large mills from several adjoining counties, and are here credited to counties where sawn.

*Partly estimates made by lumbermen. †No reports made. ‡Mills destroyed before the end of the year. ⁒Reports incomplete.

The output is at least one-tenth less than it would have been under normal trade conditions, since 107 mills, with an output of 230,000,000 feet, board measure, reported an average idleness of seven weeks. Many mills also that did not shut down considerably reduced their output during a part of the year. The unprecedented freeze during the month of January, 1893, caused many mills dependent upon the water-courses for their supply or operation to shut down for several weeks. The output would otherwise have been over 500,000,000 feet.

In the preceding statement the output for the respective counties does not necessarily mean that the timber was produced in them, but merely that it was manufactured in these counties. Camden, Chowan and Perquimans counties now produce but a small proportion of the timber manufactured in them; it comes from Bertie, up the Chowan river, and the counties lying on the southern side of Albemarle sound.

The proportion of timber produced by individual counties is more nearly represented by a subsequent table showing the amounts of timber and timbered lands held by logging and milling companies in each county, though there are given no actual figures of the production of timber by counties. There are only a few towns in the State which have a large annual output, the mills in general being scattered through the timbered districts.

The relative rank, capital invested, yearly capacity, output and value of output of the three producing points, for 1893, were as follows:

Capital, Output, etc., at Different Lumber Markets in Eastern North Carolina, 1893.

Towns.	Rank.	No. of establishments.	Capital.	Output for 1893, feet, board measure.	Yearly capacity.	Value of output, 1893.
Wilmington	1	8	$530,000*	36,000,000	48,000,000	$425,000†
Newbern‡	2	9	385,000	38,000,000	51,000,000	350,000
Washington	3	7	165,000	21,000,000	27,000,000	188,000

*Not full, partly based on a bulletin of the U. S. Census of 1890.

†Partly taken from the custom-house records of Wilmington.

‡Includes James City, a village on the opposite side of the Trent river.

The apparent disproportion between capital and value of output in the various statements is due to the different extent to which remanufacturing is carried at different places. Wilmington, too, largely increased during 1893 the capital engaged there in milling, but not sufficiently early in the year to increase the output in like ratio. The output of no shingle-mills or remanufacturing establishments except such as are connected with lumber-mills is included in the above. Elizabeth City and Edenton, with twelve mills, had a combined output of 38,000,000 feet, board measure, and 21,000,000 shingles. The shingles made in these places were largely from juniper or white cedar; the lumber was chiefly made from the loblolly pine. All except a small part of the output of Wilmington was from long-leaf pine, that of Newbern and Washington was largely loblolly pine, less than five per cent. being long-leaf. The Aberdeen district in Moore county, and the western part of Cumberland county produced in 1893 over 31,000,000 feet of long-leaf pine.

LUMBER PRODUCT FROM DIFFERENT SPECIES OF TREES.

The output in eastern North Carolina, 1893, of lumber and shingles was distributed according to kind of tree as follows:

Lumber Product from Different Kinds of Trees, 1893.

Kind of Timber.	Lumber, thousand feet, board measure.	Shingles.
Loblolly pine*	288,090	.....
Long-leaf pine	148,600	10,300,000
Cypress	6,275	111,680,000
Juniper (white cedar)	6,300	44,200,000
Ash	5,000	.....
Yellow poplar†	2,400	.....

*The savanna and short-leaf pine were sawn along with the loblolly and not distinguished from it, so there was no way of getting any accurate information about the quantity of these that was sawn. The savanna pine formed a large part of the material sawn at some mills in the extreme east, but there was no appreciable amount of short-leaf pine sawn except along the western boundary of the pine belt. Loblolly pine was reported as being sawn in thirty-three counties, and in twenty of these no long-leaf pine was sawn. Long-leaf pine was sawn in twenty-one counties and entirely sawn to the exclusion of the loblolly pine in six counties. The counties which produced the most loblolly pine were Beaufort, Bertie, Columbus, Craven, Dare, Gates, Halifax, Hertford, Jones, Lenoir, Martin, Onslow, Perquimans and Washington. Those which produced the most long-leaf pine were Cumberland, Moore, Richmond, Sampson and Robeson counties.

†Including small quantities of persimmon, sweet-gum, oak and dogwood.

Of the above amounts of lumber sawn there were 138,420,000 feet remanufactured at the mills, of which 101,420,000 feet were of loblolly pine and 37,000,000 feet were long-leaf pine. Besides this it is estimated that there were 45,000,000 feet of both kinds remanufactured at separate establishments in Moore, Richmond and Perquimans counties.

The amount of lumber used locally, including that shipped to other points in North Carolina, was 79,200,000 feet, of which 52,000,000 feet was long-leaf pine lumber. It seems that long-leaf pine lumber is much more widely used in the State than that made from the loblolly pine. This is because the long-leaf pine timber lasts so much longer than that of other pines when used in exposed situations, as is generally the case in this State. Most of the loblolly pine used in North Carolina is sawn in the counties where it is used. What is exported goes to the Northeastern States, about the same amount going by rail as by water. The long-leaf pine lumber, except that from Wilmington, goes to Virginia, Pennsylvania, and other interior States. That from Wilmington goes to coastwise ports and to the West Indies.

LUMBER SHIPMENTS FROM WILMINGTON.

The total shipments of lumber, the foreign exports and the value of the latter, from Wilmington for the years 1873, 1883 and each year of the past decade were as follows:

Quantity and Value of Lumber Shipped from Wilmington, 1873–'93.

Year.	*Total shipments of lumber, feet, b. m.	†Total foreign exports of lumber, feet, b. m.	†Value of foreign exports of lumber.	Year.	*Total shipments of lumber, feet, b. m.	†Total foreign exports of lumber, feet, b. m.	†Value of foreign exports of lumber.
1873	19,517,768	6,920,171	$.....	1888	41,067,686	13,019,000	$190,681
1883	40,281,158	9,074,077	.....	1889	36,679,509	10,695,000	172,487
1884	37,076,042	15,319,000	232,537	1890	40,289,205	13,824,000	212,094
1885	35,956,829	14,912,000	238,983	1891	40,065,567	17,532,000	287,448
1886	39,512,249	9,053,000	145,968	1892	29,580,160	12,224,000	174,446
1887	.....	11,190,000	174,121	1893	25,874,331	13,244,000	175,699

*From the records of the Wilmington Board of Trade. For the compilation of these figures and others obtained from these records the Survey is indebted to Col. J. L. Cantwell, Secretary of the Wilmington Board of Trade. These figures indicate the number of feet in board measure.

†From the custom-house records.

PRODUCTION AND EXPORT OF SHINGLES.

The greater part of the sawn cypress shingles, and all of the first-class white cedar (juniper) shingles manufactured in the State, have been exported. The greater part of the pine shingles have been used locally. Wilmington was the only point in the State that has shipped any shingles to foreign ports. It also had a large domestic trade. The total exports of shingles from Wilmington, the foreign exports, and the value of the foreign exports for the years 1873, 1883, and each year of the past decade are shown by the following table:

Quantity and Value of Shingles Exported from Wilmington, 1873–'93.

Year.	Total Exports.	Domestic Exports.	Foreign Exports.	Value of Foreign Exports.
1873	6,338,836	3,960,580	2,378,256	$.....
1883	6,635,851	4,748,951	1,886,900	.....
1884	10,140,707	6,510,707	3,630,000	18,936
1885	7,191,335	3,894,335	3,297,000	18,936
1886	9,265,560	7,677,560	1,589,000	8,749
1887	5,726,453	3,499,453	2,227,000	11,750
1888	6,663,950	2,622,950	4,041,000	21,125
1889	7,316,912	3,593,912	3,723,000	17,946
1890	8,935,064	5,305,064	3,630,000	19,249
1891	5,958,520	3,732,520	2,226,000	12,930
1892	10,274,329	7,358,329	2,916,000	15,519
1893	18,167,500	6,314,500	1,853,000	9,806

Much the larger part of the shingles shipped from Wilmington are hand-drawn or rived cypress shingles. These are made entirely in the surrounding counties, especially those along the Cape Fear river. The making of drawn shingles, both from cypress and long-leaf pine, is an industry that has rapidly declined during the past decade. Estimates given by shingle dealers at Wilmington, Newbern and Washington, and smaller places along the seaboard, show a falling off in the production of one-half or more since 1880. This falling off is largely due to the fact that the supply of the best quality of cypress which could be easily reached in the swamps has been in a measure exhausted. The number of rived pine and cypress shingles estimated to have been made last year (1893) was 22,800,000, valued at about $55,000.

CAPITAL INVESTED IN THE LUMBER INDUSTRY.

The capital reported as invested in milling was $4,690,000. This was engaged as follows: In milling plants, stock and live assets, $3,471,100; in timber lands, $817,432; in railroads and rolling stock, $408,800. Seventy-four establishments reported that they owned or controlled 630,700 acres of timbered land. Of this 298,700 acres were loblolly pine lands, 219,200 acres were white cedar (juniper) swamp, 89,800 acres cypress and gum swamps, and 24,000 acres long-leaf pine lands. About 300,000 acres of this, including the cypress and white cedar land, is owned, and the rest is controlled for a limited number of years.

The registers of deeds of ten counties reported $158,934 invested in timber lands in their respective counties, by logging or milling companies of other States. This represented 114,995 acres of land. The swamp land amounted to 51,230 acres and the loblolly pine lands to 63,765 acres. In this connection was also reported 20,000,000 feet of standing loblolly pine, valued at $22,000. This was situated in Gates, Hertford and other northeastern counties. Bulletin No. 5 of the U. S. Census of 1890 reported 111,418 acres of yellow pine and cypress land, with an estimated total product of 953,770,000 feet, board measure, of merchantable timber, and a value of $346,885, to be owned in North Carolina by milling establishments located in Michigan and Wisconsin.

The $408,800 invested in railroads and rolling stock represents eighteen roads, with 194 miles of track and their necessary equipment. Besides this there are eight railroads exclusively or largely engaged in handling lumber and timber, which had 96 miles of track, and were taxed in 1893 on a valuation of $256,300.

The capital reported as invested by millmen in lumbering does not by any means represent the total amount of capital engaged directly or indirectly in milling. Forty-two establishments reported 171,800,000 feet, board measure, of their logs as having been brought to the mills by outside capital. This is 31 per cent. of all the logs brought to the mills. The number of persons engaged in handling this timber, taking them to be 45 per cent. of those engaged in logging, in the employment of the mills, was 1,300.

This, with the total number reported as employed by milling companies in logging, makes 2,800 engaged in this branch of the industry. The total number of hands reported as employed in the entire industry, in handling the material from the stump to the finished product, was 8,320.

The rafting of timber to the mills is done by farm laborers during the dull seasons of the year. The price paid at the mills for this timber is from $3.75 to $5 a thousand feet, board measure, for loblolly pine, and from $3 to $6 for cypress and ash, according to the quality of the timber and situation of the mill. Long-leaf pine brings the same prices as loblolly pine.

THE PRODUCTION OF LUMBER IN NORTH CAROLINA IN 1893.

EXPORTS OF CRUDE LUMBER.—There were operating in North Carolina in 1893 three timber companies, with a capital of $40,000, reported as engaged in logging for establishments in other States. During the year 1893 there were exported by these and other logging and milling companies logs amounting to about 110,000,000 feet, board measure, to establishments in other States. This amount exported was nearly one-fourth the entire amount manufactured in the State. It consisted mostly of loblolly pine, with some cypress, and had an estimated value in raft in this State of $500,000. It went out by way of the Chowan river, and through the Dismal swamp canals and partly by rail. This timber was manufactured chiefly at Franklin, Whaleyville, Suffolk and in the vicinity of Norfolk, Va. Besides this there was exported 9,800 cords of white cedar billets, valued at $62,000, chiefly to Philadelphia, Richmond and Norfolk. This, however, cannot begin to represent the total amount shipped, since the white cedar was shipped in small amounts from a great many different places, so that but little knowledge could be gained from these sources about the amounts shipped and their value.

RECENT GROWTH OF THE LUMBER INDUSTRY.—An endeavor was made to ascertain the increase of capital invested in milling and the increase in output since 1890, and also to find the amount of increase during 1893. While the number of new plants erected since 1890 was gotten, the capital invested in those that had stopped run-

ning or indefinitely suspended, and their annual output, could not be accurately ascertained. The following table represents, however, very nearly the increase since 1890 in capital, annual shingle and board capacity for mills sawing long-leaf and loblolly pine and cypress lumber:

Increase Since 1890 in Capital and Productive Capacity of Lumber Mills.

	New Establishments.	Capital Invested.	Board Capacity, in feet.	Capacity in Shingles.
Loblolly pine and Cypress.....	18	$1,011,300	85,000,000	38,000,000
Long-leaf pine	14	73,000	28,000,000	2,000,000
Totals.....	32	$1,084,300	113,000,000	40,000,000

It was also ascertained that in this same time about twenty plants, with an annual output of 25,000,000 feet, had ceased running. The above increase in loblolly pine mills lay largely in Washington, Onslow, Martin, Lenoir, Halifax, Craven, Columbus and New Hanover counties, and in long-leaf mills in Moore, Nash and Cumberland counties.

The total increase in capital for the year 1893 was $392,000, and in yearly capacity was 46,000,000 feet.

There was besides this an increase for 1893 of twenty miles of logging railroad, valued, with the rolling stock, at $80,000.

MISCELLANEOUS WOOD-WORKING INDUSTRIES.

There are several minor industries in eastern North Carolina which are largely or entirely dependent upon timber for their products and which annually consume large amounts of timber or wood.

One of the most important of these industries is that engaged in the manufacture of cooperage. The stock establishments engaged in the manufacture of cooperage in North Carolina during 1893 are situated chiefly in the eastern part of the State, and included three barrel factories making truck barrels and boxes, with an output of 53,000 barrels and 1,790,000 staves, valued at $22,000; two bucket factories using white cedar; and a great number of

small cooperage concerns engaged in making casks for spirits turpentine from oak, and barrels for rosin and crude turpentine from pine. The barrels for truck were made partly from pine "slabs," with wire hoops, and partly from black-gum staves with cypress hoops and yellow poplar heads.

Besides this there was a large amount of cooperage material, staves, headings and hoops, manufactured in Washington, Dare and other north-eastern counties from cypress and white cedar. The census for the year 1890 reports that there were that year eighty-three establishments manufacturing cooperage in North Carolina, with a capital of $34,542 and an output valued at $111,925.

There are a number of special manufactories in the State, including veneer works, spoke and handle factories, etc., using nothing but wood in the manufacture of their products, or largely dependent on wood. The character and extent of these manufacturing establishments and the practicability of increase in the State will be made the subject of a special Bulletin to be published by the Survey at an early date.

PRODUCTION OF TIMBER OTHER THAN MILL TIMBER.

"Ton Timber."—The forests of eastern North Carolina once furnished a large quantity of very valuble pine stocks of exceptionally large size and superior quality, under the name of "ton timber," which were used in naval architecture, and for other purposes requiring extra large strong timbers. These stocks came from both the loblolly and long-leaf pines, the former furnishing the longest and largest pieces. The finest trees for these uses have been removed wherever accessible, and though some of these stocks are still gotten out each year their size is not so large and their quality is not so high as formerly.

During recent years the largest of these stocks have come from up the Cape Fear river, being that growth of loblolly known as rosemary pine. They are procured here and there, only a few at a place, in separate localities, by a number of contractors, so that reliable information as to the amount of production could not be obtained. However, at least 20,000 feet, scale measure, were

exported last year to coastwise and to European ports. A larger quantity of this timber was shipped from Wilmington than from any other point.

Railroad Ties.—One of the most constant demands for the best heart pine and young white and post oaks is for making railroad cross-ties. The eastern part of this State not only furnishes all the timber required for the construction and maintenance of its own lines of railroads, but annually exports several thousand cross-ties to other States. There are about 400,000 cross-ties required yearly to maintain the existing lines of railroad. Of these 400,000 ties about one-half are all-heart long-leaf pine, and average about $7\frac{1}{2}$ feet long by 9 inches broad and 6 inches thick, each containing about 3 cubic feet of wood. The oak ties are larger, especially broader, and are being used more than formerly. There are some cypress and a few white cedar ties in use, and on some roads loblolly pine ties are used. The average price paid for hewn ties is about 22 cents each. As near as could be ascertained there were 22,000 white cedar and cypress, and 30,000 pine ties, exported during the year 1893.

Telegraph Poles, etc.—These are cut from both cypress and white cedar woods. About 7,000 poles are annually required for use in this State, and besides this about 12,000 white cedar telegraph and electric light poles, valued at about $27,000, were shipped during 1893. The requirements for such white cedar poles usually are that they shall have few knots in them, and very few are cut under 14 inches in diameter at the larger end, so that the finest stocks are required to make them. It would be advisable for more care to be taken of juniper "bays" and swamps after they have been lumbered. Their soil is generally too peaty to be used for agricultural purposes, so that the only real use to which these lands can be put is to let grow on them the young white cedar left after they are cut over. Precaution should be taken to prevent these swamps from being burnt over, during dry seasons, as the forest fires not only destroy the young growth of white cedar, but also burn the thin layer of organic matter, consisting of sphagnum, peat and buried cedar logs, clear down to the sand subsoil, and thus destroy the possibility of a future supply of this timber.

THE PRODUCTION OF OAK STAVES.—From 1840 until 1880 there were annually made in the north-eastern counties many thousand white and red oak staves. During the last fifteen years, however, this industry has declined to a very small part of what it once was. Staves were very largely shipped from Beaufort county to the West Indies, prior to 1860. "Red oak staves" made from black, scarlet, water and spanish oaks were preferred for this trade; while for the European trade, which went by way of Norfolk, New York or Baltimore, "white oak staves" were preferred. The latter were made from white oak, post oak and overcup oak. Between 1868 and 1880 the counties around Albemarle sound produced large numbers of staves, but the practical exhaustion of the best accessible oak has largely reduced their output. Nash county now produces a considerable number of oak staves, and this is the only county in the eastern section of the State that does. Further west, however, large quantities of such staves are made in the upland oak forests which extend through the middle and western parts of the State to Tennessee.

AGGREGATE VALUE OF THE FOREST PRODUCTS OF EASTERN NORTH CAROLINA.

The values of all the timber and lumber products of eastern North Carolina for 1893 may be said to have been as follows:

Value of lumber, including sawn shingles	$4,558,280
" " round timber exported	562,000
" " "tun" and hewn timber exported	12,000
" " railroad ties produced	110,000
" " telegraph and electric light poles	27,000
" " hand-made shingles	55,000
" " products of special manufactories (U. S. Census, 1890),	131,055
" " cooperage products (U. S. Census, 1890)	111,925
Total	$5,567,260

To this amount can be added the value of all resinous products, which amounted, in 1893, to $1,752,760; and we have as the approximate market value of the forest products for eastern North Carolina in 1893, $7,320,020. This does not show the real total value of the forest products of this section, since practically all the

fencing material is wood, and over nine-tenths of the fences are made from rails manufactured on the farms and not included in the above amounts. Neither is there included in the above any of the fire-wood, which constitutes nearly all of the fuel used in this section, both for manufacturing and domestic purposes. The value of the fencing cut up, and the cord wood in piles, would amount to considerably over $4,500,000 a year, for the quantity of both consumed in eastern North Carolina, and this added to the value of the other products, makes an aggregate value of about $12,000,000 for the forest products of this section, for one year. This makes the forest industry one of the largest in the State. The cotton crop of the entire State had in 1890 a value about equal to this amount.

RECENT TIMBER DEVELOPMENTS, AND THE OUTLOOK.

The tendency of the lumber industry in North Carolina is towards larger establishments, turning out at the mills as highly finished a product as possible, such as flooring, ceiling, moulding, etc. The wisdom of this course is fully sustained by the fact that there were in these eastern counties, in 1880, 306 establishments, which had an output valued at $1,340,000; while in 1893 there were only 323 establishments, with an output of $4,559,000. There are now in operation nine band saws, five of which have been put in since 1890; and the change from circular to band saws is being contemplated by several other establishments, since there is a saving in them, not only of motive power, but also a great saving of timber.

Most large mills which will be built in the future, at least those for sawing loblolly pine, will be furnished with band saws.

The next ten years will probably show a much greater increase in milling than the past decade, and a very much larger development of the loblolly pine and hardwood industry. There are several counties in which the loblolly pine has as yet no commercial value, and in which it is only sawn in small quantities for local use. The fact that the mills using this kind of timber, and owning timber land, reported over 2,000,000,000 feet in sight, insures them sufficient material for many years to come. Besides this, the area still unlumbered and not controlled by lumber men, must have at least twice as much standing timber on it as was reported by

millmen for their lands. This does not include any regrowth which is now occupying areas already lumbered.

USES OF THE IMPORTANT WOODS IN EASTERN NORTH CAROLINA.

The *long-leaf pine* serves for more uses than any other tree of this section. Its largest uses are for heavy building material for houses, bridges, trestles and other places where great strength and length of timber are required; for tank plank, flooring, ceiling, weather-boarding, shingles, railroad cross-ties, and filing. Its special qualities as a wood are not yet sufficiently understood by consumers, and it is put to a great many uses to which an inferior and weaker timber might as well be applied. Its use as tank plank is one to which it has only lately been extensively put, but one to which it is well adapted on account of its durability. It is extensively used for fencing and posts, and in the form of split rails, throughout all the south-eastern section of this State.

The *loblolly pine* is manufactured chiefly into flooring and ceiling, and to some extent into scantling for frame work, bridge timber, etc. For the last uses the wood is not so well suited as that of the long-leaf pine, though it is extensively used when the long-leaf cannot be gotten. Railroad cross-ties are made from it in the north-eastern counties, but they decay rapidly, since they are largely or entirely of sap wood, and are in contact with a soil unusually damp during the greater part of the year.

The *short-leaf* and *savanna pines* have the same uses as the loblolly, though the wood of both trees is different from that of the loblolly. The loblolly pine is also largely used for fencing.

The *yellow poplar* is manufactured into boards for box stuff, and some of the best quality of lumber into furniture squares. The poplar of the eastern swamps, however, is of an inferior quality when compared with that from the western part of the State, and can only be put to secondary uses. It makes excellent fencing.

Ash is sawn into furniture squares, banister and newel post pieces, and some of the lower grades of wood into boards. Barrel hoops are extensively made from it. Like the poplar its quality is not as high as the ash from the western counties.

White cedar (juniper) is now recognized as one of the most

valuable woods of the eastern United States, and decidedly the most valuable in the eastern part of North Carolina, where it has a large and constantly increasing number of uses. It is employed for making cooperage ware, pails, tubs, railroad tank plank and boat plank, shingles, sashes, railroad ties, telegraph and telephone poles and for fencing. All of these services to which it is put are based on the property it possesses of withstanding exposure to moisture, or alternate wetting and drying, and its small shrinkage. In this State it is also used in the manufacture of cheap furniture, and is said to be particularly suited for such, being easily worked, shrinking very little, and being light.

Cypress is largely used for shingles, and in other ways in which white cedar is used. Besides, on account of its great size, wide paneling, wainscoting and building material, sashes, blinds, exterior mouldings, and other wood-work exposed to the weather, are made from it. The poorer quality wood, where it is worm-eaten and "peggy," is sawn into fence boards.

The uses reported for the other woods were very few, and indeed very little of them is being sawn. Some *sweet-gum* is sawn into lumber for making furniture, but it warps so badly that it is difficult, even when kiln-dried at once, to get good boards for shipment. A use for which it is well adapted is to make veneer ware, butter and lard dishes, crates, small baskets, etc., and it is being largely employed in such manufactures in the eastern section. For making the veneer, the gum logs are cut to a uniform length, steamed thoroughly to soften the wood, placed in a large turning lathe the chisel of which takes off a thin sheet of wood as broad as the log is long. The chisel is moved automatically nearer to the center of the log with each revolution of the latter to make the sheet taken off of a uniform thickness. These sheets are then cut to size and pressed or bent into the shape desired, and steam-dried to prevent any warping.

The *black-gum* is being used for making staves and crates for use in trucking, for which uses manufacturers say it is well suited, not being heavy, and about the cheapest material that can be gotten.

Several thousand feet of *maple* was reported by one company among their products as being sawn for use in finishing the interior of railroad cars.

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ERRATA.

Page 22, line 14 from top; read *appressed* for *oppressed.*
Page 28, line 7 from top; read *compact* for *large.*
Page 31, line 19 from bottom; read *unlumbered* for *untimbered.*
Page 33, line 9 from top; read *exploitation* for *exploration.*
Page 38, line 18 from bottom; read (p. 32) for (p. 20).
Page 42, line 12 from top; insert *annually* after *and there is.*
Page 50, line 8 from top; read *occur* for *occurs.*
Page 118, line 16 from bottom; read *tun* for *ton.*